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ABSTRACT

This training package is designed for use by staff of the U.S. Bureau of Apprenticeship and Training who are participating in a course dealing with apprenticeship in the future. Addressed in the individual units of the course are the following topics: employment trends of the future (computers, robotics, communications, growth and declining occupations, future employment projections, and the effects of each of these factors on apprenticeship); apprenticeship training, job analysis, modular training, computer-based training); and marketing apprenticeship (using techniques of marketing, marketing campaigns, conducting a briefing, performing a cost/benefit analysis, and researching). Each unit is subdivided into a series of modules containing reference materials (the content of the course lectures, supplementary articles, bibliographies, and sources of further information); exercise materials; and an apprentice training resource guidebook (charts, forms, and summaries of the most important information from the module). The final section of the package is designed for use as an on-the-job desk guide. (MN)

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Apprenticeship in the 80's
A Training Program for the Bureau of Apprenticeship and Training

U.S. Department of Labor Employment & Training Administration

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INTRODUCTION

Introduction

This is the Participant Handbook for Apprenticeship in the Future, a training course for the staff of the Bureau of Apprenticeship and Training This course is divided into three units, each of which is designed to be delivered as a full day of training. These units, and the topics covered in each, are listed below.

Unit A: **Employment Trends of the Future**

- Computers and their Applications
- Robotics
- Communications
- Growth and Declining Occupations
- Future Employment Projections
- Effects of the Above on Apprenticeship

Unit B: **Apprenticeship Training Techniques**

- Performance-Based Apprenticeship Training
- Job Analysis
- Modular Training
- Computer Based Training

Unit C: **Marketing Apprenticeship**

- Techniques of Marketing
- Marketing Campaigns
- Conducting a Briefing
- Cost/Benefit Analysis
- Researching

The materials are arranged by module, with each module divided into three sections. The first section, Reference Materials, contains the content of the lectures, supplementary articles, bibliographies and sources for further information. In the second section, Exercise Materials, you will find instructions and background information for the exercises that are a part of this course. In the final section, ATR Guidebook, you will find summaries of the most important information from the module and other charts and forms as appropriate. In addition, some modules contain a bibliography and a glossary. This final section has been designed so that your can use it as a desk guide back on the job.

If you have any questions concerning this handbook, please ask your trainer for further explanation.

UNIT A
EMPLOYMENT TRENDS

MODULE I
FORECASTS FOR THE FUTURE

REFERENCE MATERIALS

Test Your Computer "IQ"

If you own a personal computer	10 points
If you use one regularly on the job	10
If you read any computer magazines	3
If you've taken CAI programs	5
If you've ever done any programming	7
If you can define clearly all of the following ROM, RAM, Videotex, Byte	5
If you've ever used a time-sharing system	7
If you intend to buy a personal computer within 6 months	2
If your job will allow you to use a computer within 6 months	1
If you can clearly define: hardware, software, data base	5

Total: _____

SCORING

40 or over -- An officer in the computer revolution.
25-39 -- A foot soldier in the revolution.
8-24 -- The revolution is proceeding without you.
0-7 -- What revolution?

The Revolution Around Us

A sociologist by the name of Wilbar Schramm has made the point that it took 50 million years for mankind to move from oral to written communication, 5,000 years for printing to evolve from writing and 500 years to move from printing to something called television.

Today, TV is about 40 years old. Fifteen years ago nobody had a pocket calculator. And only five years ago there were no advertisements for personal computers.

Future shock has become reality. The rate of change is accelerating at an incredible pace, and we are all bumping along in its shock waves. But we don't always notice what is causing the bumping. Largely because of the speed at which we're moving, we've become blase about even the most dramatic events. For example, the fifth space-shuttle mission last November went virtually unreported. A lot of people didn't even know it was up there. Do you remember the name of even one of the astronauts on board?

Especially in the training and development community, trends are upon us before we know it. And, as with waves, we tend to focus on the approaching one without even noticing the bigger, meaner one behind it. Two of these monster waves will carry special significance for trainers. We would all be wise to increase our awareness and understanding of them.

TREND #1: THE COMPUTER REVOLUTION

This title is something of a misnomer. We are really experiencing a microprocessor revolution. Computers have been among us since the late 1940s, but the microprocessor allowed the miniaturization which has enabled the computer to become a daily companion and easily accessible tool. And, unlike so many other breakthroughs that rely on expensive, rare materials, the basis for this revolution is the extraordinarily abundant raw material silicon.

Here are some statistics that should impress even the most unaware. In 1980, 35,000 personal computers were sold. In 1983, sales of 3.5 million are projected, an increase of about 9,900%. As of June 1982, there were 500,000 in the home; by December of that year, an estimated 1.5 million were installed. By the end of this year, a projected 274,000 desktop computers will be installed in schools--more than double 1981 figures: The Wall Street Journal recently estimated that one million will be in schools by 1986. On the business front, while a mere 3% of professional, managerial and administrative workers currently use personal computers, according to Business Week estimates, 65% of these workers will use them by 1990.

And prices have been plummeting. Some basic units now sell for $99. Heavy competition and advances in technology are producing further miniaturization and further price-cutting. The marketing arm of the computer industry is finding plenty of buyers for its pitch that the machines are useful in almost all facets of one's life: education, entertainment, shopping, banking, home management, energy, security, communications and so on. Right now, electronic mail is being left on computer networks all over the country. People are conversing computer-to-computer in a manner similar to citizens' band radio. Time-sharing enables the little machine on your desk to access data bases and calculating potential of enormous magnitude.

Some other statistics that have a bearing on all this:

- The typical executive now spends 94% of the workday on communications, and only 3% on functions such as problem-solving and planning (Management Review, February 1982).
- Between 6,000 and 7,000 scientific articles are now written every day. This base currently is growing at a rate of 13% a year. The growth rate is expected to jump to 40% a year (Esquire, September 1982.)
- The Stevens Institute of Technology, as well as other schools, now requires freshmen to purchase a $750 Atari microcomputer--representing about 1.5% of their four-year tuition cost (Fortune, September 20, 1982).
- Voice-actualized computers are coming. The Japanese, in particular, are making tremendous strides in this area. Ever ride in a Datsun and have the car talk to you?
- Fifteen-million workers are expected to earn their income at home, using some form of computerized help, by the mid-1990s (Business Week, May 3, 1982).

The computer revolution is often compared to the industrial revolution, one doing for the mind what the other has done for muscle. However, there are some clear and important distinctions about the computer revolution:

- We are aware that it is going on.
- It is occurring within one generation.
- It is not localized.
- It is being documented and, to a large degree, "guided."
- It pervades nearly every aspect of our lives.

The implications for those of us in human resources development are just beginning to be understood. For one thing teaching is going to occur more and more at what theorists have called the "teachable moment." Whether in school or on the job, the learner is going to be able to combine the learning with the actual experience. An insurance underwriter, for example, might receive instant instruction, testing and feedback while evaluating an actual application form. This should make learning much more palatable, more relevant, and more effective.

Another implication is that almost everyone is going to be computer literate. First, school children are being raised on computer terminals, due largely to far-seeing donations of equipment by manufacturers. Secondly, even the most "old school" managers will find computers increasingly irresistible, and will no more decline to use them any more than they decline to use calculators or telephones. That's because the machines are becoming increasingly "user-friendly," meaning you no longer need a degree in programming to work with one. Indeed, within a few years most will be accepting basic commands in plain English--and some machines will be speaking English as well.

A third implication is that the "fount of knowledge" at the front of the classroom is going to disappear. This is not to say that the exceptional instructor, enthused about the subject and able to motivate students accordingly, will be forever exiled. But let's face it: that instructor is all too rare anyway. People will be learning at their own speeds, individually, and will tend to assemble into groups only after they have absorbed relatively equal amounts of information. (What will be unequal will be the time each took to do the learning.) The instructor then will help the group resolve questions and help individuals plan their own applications of what they have learned. This is a significant advance over most present classroom settings, in which the instructor is too slow for some and too fast for others.

Still another implication is that personal use of the computer will intertwine with job-related use. The desktop machine at home and the one at work will be used interchangably for business and personal affairs. If all aspects of one's education come to involve the computer in some fashion, the employer will tend to be sucked willy-nilly into that educational process--if only in the sense that some of it will occur on the employer's time. Employees may come to regard personal learning--perhaps completely unrelated to the job--as an unexpected benefit. This could prompt a much stronger shift toward corporate paternalism as the business world's prevailing "style."

The potential for a "dehumanizing" effect in the work place is fairly high. On the one hand, there will be an increase in remote learning, with people learning by themselves, perhaps not even on the company's property. But on the other hand, there will be an increased need for attitudinal training to handle such isolation. Alternative forms of what might be called "business socialization" will emerge. Who will provide such assistance? You will.

We could go on and on in this vein. One projection is the "one set of books in the world" theory. It means literally that: just one set of books, accessed by computer terminals with great ease. What about your personal reading? You'll have one exquisite, leather-bound book holder into which you'll insert the microchip of your choice. You can store thousands in a cigar box, and buy all of John Updike's works for $5. Let's let Mr. Updike worry about the royalties.

The problem is that while access to large amounts of data will be simple, the task of sifting through that data and using it effectively will be tougher than ever before. It is a fallacy that the computer makes decision-making easier; the machine simply makes data-gathering easier.

Someone has to provide training in what to do with the newfound riches. That someone will be you.

The computer revolution will radically alter the way in which people learn, in some cases changing the venue of the learning itself. Coupled with the second major element in the revolution around us, it will transform our lives.

TREND #2: ADULT EDUCATION AND THE LIFELONG LEARNER

The baby boom has burst. Schools that proliferated to accommodate the post-war boom now sit with empty classrooms. Some statistics:

- In the 1980's, the 25-to-44 age group will grow by 26% to 79 million people (Boardroom Reports, June 1982).
- The over-55 group will grow at twice the overall rate.
- The over-65 group will reach 12.2% of the total population, compared to 9.8% in 1970.

We have huge "education-distribution entities" in place. The logical strategy for their survival is for them to sell their technology to the new mass market older age groups.

New areas of competition are developing right now. The contestants include private education firms such as the Dale Carnegie enterprises; training companies; nonprofit organizations (local YMCAs); trade associations (American Bankers Association); professional service companies (Arthur Andersen); graduate and undergraduate schools of all kinds; firms that previously provided training only to their own employees (3M now sells its training products); publishing companies (McGraw-Hill); moonlighting professors; consulting "firms" ranging from organizations like McKinsey to private individuals; vendors of correspondence courses; computer manufacturers; software writers and publishers; and, finally, internal company training departments.

Get the picture? Education is big business. It is often cited as one of the four growth industries of the '80s. And the entire concept of "the campus," where 30,000 students are housed, fed, clothed, parked and, eventually, educated, is becoming a thing of the past. The primary target of educational efforts will be the adult learner. That trend will be reinforced by corporate paternalism, continuing fascination with "quality of life" issues, and an emphasis on lifelong learning.

There are ample indications of the growing power of this "wave." According to The Wall Street Journal, an organization called the Network for Learning did a $1.9 million business in 1981 by providing discussions on such subjects as "How to Choose a Wine" and "How to Start a Conversation" for $26 per participant. Books are being recorded on cassettes--something once done exclusively for the blind--to be listened to while commuting in the car. The National Home Study Council claims that three million people are enrolled in correspondence courses, and about 300 homestudy organizations exist to serve them.

Air travel has been the sophisticated business route of the '70s. Teleconferencing will supplant it in the '80s.* Aside from the financial savings, time savings and reduced personal disruption, teleconferencing is instantaneous and can involve any number of people. It will have a considerable impact on the adult learner.

For example, there is no technical reason why a economics expert (or physicist, or jurist, or tax expert) can't appear simultaneously before 100 groups scattered around the nation. Several of those groups might be involved on an interactive basis, able to ask questions or challenge conclusions. On local and community levels, cable television has made the same sort of thing possible in certain locations. Experiments have allowed people to "vote" from their homes during city council meetings, for example.

Local cable companies, in fact, represent another major growth industry, and most have more channels available than programming to fill them. In Montgomery County near Washington, D.C., the local cable network uses only 36 of 60 channels. Two of those are filled by university courses, one of which bestows credit toward a degree.

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* Editor's note: The opinions of airline industry analysts vary widely regarding the significance of teleconferencing as a threat to business travel.

In *The Changing World of the Executive* (Time Books, New York, 1982), management theorist Peter Drucker observed that there are three emerging groups rife for education: the affluent retired, young adults from the baby boom, and married, working women. The impact of working women on adult education is just beginning to be appreciated. According to *Time* magzine, one-third of the 1981 graduating class of Harvard Medical School was female; in 1982, 30.2% of all law graduates were female. At the moment, 53% of all women work. *The Wall Street Journal* reported last year that a Pittsburgh department store drew 6,200 women to seminars and 3,500 people to college courses in the store!

In summary, we have an increasingly sophisticated work force, and one of its key concerns involves the quality of life. Education enhances the quality of life. That education will be provided in larger and larger measure by the employer--as a very cost-effective employee benefit--and will not be restricted to job-related skills. Most tuition-refund programs already have great leniency in this area.

"Job Benefits" will automatically include education benefits. We have already begun to see the seamier side of this: degree-granting mills underwritten by employers that bestow bogus advanced degrees as "benefits."

The combination of the enhanced learning made possible by the computer revolution and the greater need for and receptivity to it created by the adult-learner "market" will have an enormous impact on everyone connnected with human resources development. Education, training, career development and so on are going to lose their separate identities and become parts of an integrated, comprehensive system. The adult learner will be able to choose from a variety of sources and alternatives. And personal and professional growth will become part of a coordinted, holistic approach.

We are in the midst of a revolution in human knowledge of perhaps unprecedented power. HRD can play the pivotal role in enabling organizations to understand these trends and to use them as opportunities. But HRD also can be bypassed if it fails to take on that role and seeks instead to be conservative and wary of the new. It might be a time of risk, but it is also a time of great challenge and potential for bettering the conditions of the work place and the people in it. We could ask for no better opportunity.

'Bill of Rights' Serves as Guide to Technology

WASHINGTON, D.C. - The International Association of Machinist and Aerospace Workers (IAMAW) is a forerunner in the labor movement's bid to come to grips with the introduction of technology into the work place and its potentially negative impact on workers.

In November 1982, representatives of the IAMAW ratified a 10 point "Technology Bill of Rights" at the union's Electronics and Technology Conference in Seattle. The bill of rights has been distributed to union locals as a guide to be used during contract negotiations.

The union has already negotiated one government contract using the guidelines and plans to incorporate the "rights" into contracts that it will shortly be negotiating with several airlines.

'NOT AGAINST NEW TECH'

George Poulin, resident general vice-president of the IAMAW, said 'We are the only ones who have [the Technology Bill of Rights], although other unions do have two- or three point programs." He stressed that unions are "not against new technology," but rather believe that technology should be used to create jobs companywide, leading to full employment, instead of decreasing jobs.

Poulin, who is based here, explained that the guidelines were constructed to help "ease the social effects" of technology on workers and requested that:

- Increased profits as a result of labor productivity gains (from using technology) be shared with the workers involved at the local level.

- Any increase in leisure time resulting from increased productivity, such as a shorter workweek, not result in a loss or decrease of income.

- Machinery used to replace workers be taxed the same as a worker's paycheck would be taxed. This would keep a greater burden of taxes from falling on fewer workers and should be offset somewhat by the greater savings business expects to realize from using computers, Poulin said.

- New technologies enhance and enlarge the opportunities for workers to expand their knowledge and skills. Displaced workers should not be penalized; they should be compensated and either be retrained to do productive work within the company or be trained to do other work.

- Workers, through their collective bargaining units, have the right to participate in all phases of the development and implementation of technology. "We want to have as much advance notice as possible in order to take care of employees who will be affected by the change." Poulin said.

- Workers monitor control rooms and centers so that they will not be used to set standards such as quotas without being negotiated first.

- Access be controlled to personnel information, such as work and health records, that are fed into the computer. This is of "prime concern" to the union, Poulin said.

ComputerWorld, September 5, 1983

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MODULE I
FORECASTS FOR THE FUTURE

EXERCISE MATERIALS

Forecasts for the Future

1. Harvey Jones bought a pocket calculator in 1973. How much did he pay for this new gadget?

    a. $25.00
    b. $90.00
    c. $17.95

2. Mr. Jones' daughter goes to high school. This year the school granted permission for students to use calculators in school. How much will she spend for a calculator that will meet her needs?

    a. Nothing, she can get one free by opening a bank account.
    b. $3.98
    c. $12.98

3. In hotels of the future, guests will be able to push a telephone button to turn on the T.V., adjust the air conditioning or summon room service.

    True or False

4. A memory chip small enough to fit on someone's fingertip contains as much electronic logic as once filled:

    a. A four drawer file cabinet.
    b. An entire room.
    c. A 26 volume encyclopedia.

5. By the year 2000 the U.S. work force will be:

	% Information Services	% Manufacturing/Industry and Other Services	% Agriculture
a.	45	51	4
b.	66	32	2
c.	38	57	5

6. Between 1980 and 1990 the number of fast food workers in the U.S. will increase by:

   a. 22.4%
   b. 49.6%
   c. 77.9%

7. According to the BLS, high tech industries are expected to generate about _________ of all new jobs between 1980 and 1990.

   a. 5%
   b. 15%
   c. 25%

8. In 1983 new companies are being created in the U.S. at the rate of ____ per year.

   a. 600,000
   b. 900,000
   c. 50,000

9. By the year 2000 most Americans will work at home.

   True or False

10. By the year 2000 the average work week will be:

   a. 32 hours
   b. 10 hours
   c. 30 hours

11. By the year 2000 the population of the world will increase by:

- a. 50%.
- b. 100%.
- c. 75%.

12. Small towns and rural areas are growing faster than metropolitan areas in all parts of the U.S.

True or False

13. Rural crime increased by ____ in 1982.

- a. 75%
- b. 20%
- c. 121%

Forecasts for the Future

Answers to Questions

1. b.

2. All of the above

3. False, there is already such a hotel.

4. b.

5. b.

6. b.

7. a.

8. a.

9. This could be either true or false; the various forecasters are in disagreement.

10. This could be a, b, or c, depending on which forecaster is making the prediction.

11. b.

12. True

13. c.

MODULE I
FORECASTS FOR THE FUTURE

ATR GUIDEBOOK

Forecasts for the Future

TECHNOLOGY

- Three stages -- least resistance, improvements to existing systems, new uses.
- Very rapid pace
- Information age--majority of U.S. workforce somehow involved with information

TRENDS

- World economy
- Growth in rural areas--decentralization
- High tech - High touch
- New American companies created at rapid rate

Glossary

Bit - Contraction of "binary digit." The smallest amount of information that the computer recognizes, expressed as either one or zero (or on-off, yes-no, etc.).

Byte - A group of eight bits that make up one unit of information (typically a numeral or a letter of the alphabet).

CAD-CAM - An acronym for computer-aided design and computer-aided manufacturing. CAD means drawing a product on a computer screen. The computer has been programmed to perform measurements of angles and lines automatically. CAM is the process by which the computer takes the CAD drawing and turns it automatically into instructions for a manufacturing machine.

Central Processing Unit (CPU) - The "brain" of the computer. The CPU controls the other parts; its electronic circuits decode, store, and carry out instructions.

Chip - A small silicon wafer that contains from a few dozen to tens of thousands of circuits for storing and processing information.

Circuit - Any closed-loop path along which electricity can flow. In a computer, circuits form a network of interconnected paths that open and close in response to coded signals.

Disk - A magnetic storage device used to record information in the form of binary digits. "Fixed," "hard," or "Winchester" disks can store and give quick acess to large amounts of information but are expensive. The smaller, slower, but much less expensive "floppy" disks (also called "diskettes") of magnetically coated, somewhat flexible plastic are more commonly used--particularly for personal computers.

Gene Splicing - The ability to incorporate segments of genetic material, DNA, derived from one organism into the cells of another organism.

Genetic Engineering - An occupational field based on applications of gene splicing. For example, the genetic engineering field includes producing fuel from waste, laboratory production of insulin, and altering the genetic make up of grains such as corn to produce larger crops.

Hardware - The physical apparatus (boards, chips, circuits, nuts and bolts, etc.) of a computer as opposed to the set of instructions (software) that directs the computer in its operations.

High Tech - The Bureau of Labor Statistics has tried to define high tech by saying that 36 of the 977 industries with standard industrial codes (SICs) qualify because their R&D expenditures and number of technical employees run twice as high as the average for all kinds of manufacturing. Industries are manufacturers of drugs, computers, electronic components, aircraft and laboratory equipment. Service industries such as computer programming, data procesing and research laboratories also qualify.

Laser - The term laser is an acronym for a physical phenomenon called light amplification by stimulated electromagnetic radiation. Laser applications include eye surgery, welding, data transmission, and plastic cutting.

Microprocessor - A single microelectronic chip containing all the elements of a central processing unit.

Modem - A peripheral device that allows a computer to communicate over telephone lines or other communication media.

Printer - A peripheral device that converts signals into printed form. Printers may produce text or graphics of varying quality (e.g , letter or draft).

Program - A set of instructions directing the computer to perform a task. Also used as a verb meaning to compose such a set of instructions.

Random Access Memory (RAM) - The chief memory of the computer, into which all information for storage and manipulation is entered.

Read Only Memory (ROM) - Permanently stored information, usually programmed by the manufacturer and not accessible to the user. It is used to tell the central processing unit initial start up instructions, to hold a specific computer language, or to store frequently used routines.

Robot - As defined by the Robot Institute of America, the industrial robot is "a programmable, multifunctional device, designed to both manipulate and transport tools, parts or special manufacturing implements through variable programmed paths for the performance of specific manufacturing tasks."

Software - The instructions that tell the computer's hardware what to do, i.e., the programs (including the operating system). Software can be written in a number of languages such as BASIC, Fortran, COBOL, and Pascal.

Terminal - A peripheral device with a visual display and, usually, a keyboard, thus allowing data to be output (as screen display) and input (through the keyboard). Terminals are graded as "dumb," "smart," or "intelligent," depending on their capacity to process information or to have their instructions modified using only the circuits built into their own hardware.

Word Processor - A computer system (including peripherals) that has been specially designed to prepare, store, edit, and disseminate human-language tests. With the proper software, almost any computer system can be used as word processor. Word processors normally include a video display terminal and a printer.

MODULE 2
HIGH TECHNOLOGY REVIEW

REFERENCE MATERIALS

History of Computers

"These are the days of electronic marvels," said TV newscaster Edward R. Murrow in 1951. He was introducing viewers to the world's most powerful computer. The Whirlwind, as it was called, filled several rooms. It had thousands of glowing vacuum tubes, control panels bristling with switches, a keyboard resembling a clunky old typewriter's, and a tiny video screen, which at the moment was blinking, HELLO, MR. MURROW.

"Care to give Whirlwind a problem?" asked the operator.

"Let's see," said Murrow. "Suppose I was an Indian in 1626, and I got twenty-four dollars for Manhattan Island. If I had invested that money at six percent, how much would I have today?"

The operator fed the numbers into the machine on a punched paper tape. Moments later the typewriter tapped out a reply: $4,027,727,960.12.

"Very impressive," said Murrow. "What else can it do?"

The operator flipped a switch, and the $5 million computer, in notes as tinny as a cheap toy piano's, played a few bars of "Jingle Bells."

Careers Tomorrow, World Future Society, 1982

Computers
How Far Have We Progressed?

We have a pocket computer whose electronic memory is greater than the ENIAC that filled a large room in 1943. We have a desk-top computer whose memory can store what 16,000 human brains can remember. Since electrons travel at the speed of light, the only limitation on an electronic computer's processing speed is the speed of light, 186,000 miles a second. Today's state-of-the-art computer processes five million operations a second and there is a classified computer at the supersecret National Security Agency whose classified speed is more than 100 million operations a second. Classified or not, computers will reach unheard-of speeds in the next 20 years. The average computer in 1990 will do 200 million operations a second and the machines coming out of 2000 will do 8 billion operations a second. In a computer no bigger than a filing cabinet, those speeds will approach the speed of light.

Megatrends, John Naisbitt, 1982

Cost

Large-scale integrated circuits, consisting of hundreds of thousands of components packed onto a single tiny chip of material now can be mass-produced for a few cents each.

During the past five years, micro-electronic technology has increased the number of components that can be put on a chip by a factor of 100, and this rate of progress is likely to continue for at least another 10 years, resulting in a 10,000-fold increase in performance for the same cost. At this rate, by 1985 one will be able to purchase for less than $200 a pocket-sized personal computer that is faster and has more memory than the most powerful computer in the world today.

Communications Tomorrow, World Future Society, 1983

The Microelectronics Revolution
Predictions in 1979

The world is on the verge of a computer revolution that will be more rapid, widespread, and overwhelming than the industrial revolution, says the late Christopher Evans in his book The Micro Millennium. Evans proposes several possible scenarios, ranging from immediate cessation to indefinite acceleration of the development of computer technology. He concludes that development will accelerate at least through the year 2000.

During the early 1980s, computers will continue to shrink, as their capability for storing information increases and their cost declines. Computers will become the leading world industry, and IBM will displace General Motors as the world's largest corporation. Employment patterns will change rapidly.

By the late 1980s, books will be compressed to microchip form, available for about 20 cents apiece, as miniaturization slashes the cost of raw materials and distribution. Computer books can be shipped by the dozens in small envelopes or, eventually, transmitted instantly by cable or microwave. Smart encyclopedias of the late 1980s will do their own research, acting as study partners. This will lead to the erosion of such established professions as doctors, lawyers, teachers, and accountants.

Cash may no longer be necessary, because computer scanning of credit cards will transfer funds automatically. Credit cards will be equipped with a microchip that can identify its owner through a fingerprint, voiceprint, or some other unique design.

The evolution toward an ultra-intelligent machine, one that can perform any intellectual function better than man, will dominate the 1990s. Evans expects this evolution because of the commercial possibilities of such machines, the big-budget research sponsored by government, and the assistance that current and future computer intelligence can provide.

With more and more work being done by computers and computer-controlled automation, affluence will soar. This rise in the standard of living will include tremendous increases in leisure time, with a 20-hour workweek as the standard, increased vacation time, and earlier retirement. More time will be spent at home, as new communication and entertainment equipment will make even local travel unnecessary.

The effect on health may be profound. Wristwatches may be equipped with minute computers that monitor body processes, or microprocessors might be implanted within the body to detect the first sign of malignant cells. Increasingly, computers may aid with psychiatry, as sounding boards or confidants for patients.

The book also addresses the problem of enforced leisure, as people are no longer required to work more than a few hours a day. Some of this excess human energy may be channeled into sports and arts. New global goals may be proclaimed, such as a vigorous thrust into space or large expeditions under the oceans.

The Micro Millenium, Christopher Evans, 1980

General Purpose Integrated Circuits

Many integrated circuits, such as those used in calculators and watches, are specialized for a particular application. Of increasing importance, however, are general-purpose integrated circuits that can perform any task programmed by the user. These general-purpose devices are called microprocessors, and when they are combined with memory circuits and input-output devices, the result is a microcomputer, which can be used either as a stand-alone computer, linked into a computer or communications network, or dedicated to a particular task.

During the next few years, this microelectronic intelligence is likely to be incorporated into almost every product large enough to contain it, including many that use only a tiny fraction of its enormous capabilities. Many of these products will become linked together by a worldwide communications system into a vast network that will dominate our lives and fundamentally change the world in which we live.

Communications Tomorrow, World Future Society, 1982

Telephone Analogy

Microcomputers today are like telephones were when only a few people had them and before they were all connected together into a single network. Interconnection by telephone lines is already happening, but the full potential of a personal computer network will come with communications lines that have a greater information-carrying capacity, or "bandwidth," than existing telephone lines do. Optical fibers can provide this capacity, and they are already proving to be reliable and cost-effective. Optical fiber lines can be expected to replace electric wires for communications during the next few years, and as this happens, the impact of microcomputers will be increasingly felt in our daily lives.

Communications Tomorrow, World Future Society, 1982

Small Wonders: Tomorrow's World of "Smart" Machines

Computer expert Jon Roland predicts that coming advances in electronics technology will cause enormous changes in every aspect of modern society. Here are a few of the possible changes he foresees:

- **Instant Information:** Pocket-sized portable "dators," combining features of CB radio, giant computers, and the telephone system, may become the universal communications network of the 1990s.

- **Home Banking:** Personal computers may conduct all kinds of financial business directly between individuals using built-in tamper-proof mechanisms to protect privacy and prevent fraud.

- **Self-Guided Planes and Cars:** Guidance systems controlled by small computers may replace human pilots in aircraft. On the ground, similar systems will pilot vehicles safely to their destinations, coping effectively with traffic signals, road signs, and other vehicles.

- **Classroom Computers:** Students of the 1980s may build and program their own personal computer systems as a standard part of the school curriculum.

Careers Tomorrow, World Future Society, 1982

Calculators and Computers

But wait a minute! Isn't the low-priced personal computer going to do away with all these applications for the hand-held calculator? What can you do on a calculator that you can't do on a computer?

Actually, there are no computations that a personal computer can't do as well as a hand-held calculator. The big advantage of the hand-held calculator is its portability. True, it doesn't have a big TV screen. But you can carry it around with you. A computer must stay in one place. And this portability does not just apply in the field, but in the office as well. A computer occupies a work station of its own. A hand-held calculator can be moved from desk to work table. It can be carried down the hall to another office. It can be taken to meetings or conferences. Portability is important, and will keep the small computer from completely replacing hand-held calculators.

Moreover, the hand-held calculator and the computer are not necessarily competitors. They may turn out to be highly complementary. For instance, the Siemens Company of West Germany has developed a hand-held data input device that is the size of a calculator, but that is linked to a computer by an infrared beam. This data input device will initially be used on a Volkswagen assembly line, to report assembly defects to the computer that is controlling the production line. A calculator could be linked to a computer in the same way. Then, a user could get to the computer through his hand-held calculator. For instance, he might retrieve a number from a computer file and use the number in a problem-solving procedure carried out on his own calculator. Conversely, he could manipulate some raw data in his calculator, and store the final result in the computer without having to resort to punched cards, tapes, or any other other customary computer input media.

Communications Tomorrow, World Future Society, 1982

Programmable Calculators and Everyday Life

Engineers, business owners and workers, and farmers will not be the only people using programmable calculators. These calculators will also be used for recreational and hobby purposes, especially for hobbies that have some scientific or technical orientation. Already calculators are available that deal "cards" or play other kinds of games. In addition, calculators are being used to carry out the computations necessary for hobbies. For instance, calculator programs are available that allow the amateur astronomer to calculate planetary positions and other astronomical information. The penetration of hand-held calculators into other hobbies is likely to take place.

And let's not forget the ordinary person. Calculators are now availabe that keep power on the memory even when the calculator is turned off. Thus, anything stored in the memory is safe there, as long as the battery lasts. Other calculators now on the market have displays that can present letters as well as numbers. It certainly will not be long before these capabilities are combined in a single calculator. Such a calculator could become an electronic memo pad, calendar, appointment file, or telephone book. And calculators are not limited to a conventional visual display. One calculator now on the market contains a voice synthesizer to be used for speech and spelling instruction. Eventually, a calculator "memo" could give a verbal reminder at a specified time. Such a "speaking" memo could also be used by blind people who could not read a conventional display. The uses for an electronic file of this sort are limited only by the calculator owner's imagination.

Communications Tomorrow, World Future Society, 1982

Office of the Future

The "office of the future" will eliminate monotonous routine and reduce the time dedicated to intraorganizational, overhead activities. Most communication will be carried out electronically, with significant reductions in the amount of labor expended.

The trend toward electronic storage and transmission of information is leading to what is variously known as the "paperless office," the "automated office," and the "office of the future." The expectation is large productivity gains in such office functions as:

- Typing written material.
- Proofing and editing typed material.
- Handling internal correspondence.
- Filing and retrieving reports.
- Doing research.
- Drafting original material.
- Scheduling meetings.
- Billing and accounting.
- Handling telephone calls.
- Copying material.
- Mailing material.

Careers Tomorrow, World Future Society, 1983

Office Productivity

Office productivity increased by only about 4% during the 1970s, while factory productivity, spurred by automation, rose 85% over the same decade, according to the best estimates of some experts. The investment in capital equipment per office worker has been far less than that for each manufacturing employee, with some specialists estimating only $5 to $10 spent per "white collar" worker for every $100 for a "blue collar" worker.

Offices are still largely labor-intensive, employing a large number of "knowledge" workers such as managers, administrators, accountants, programmers, personnel workers, attorneys, researchers, and engineers along with their clerical support staffs. These "office workers" spend most of their time absorbing or giving information--among themselves as well as with customers, clients, and vendors. More and more, they are being forced to cope with "information overload" in an increasingly complex world.

The World of Work, Howard Didsbury, Jr., 1983

The Portable Office

For many employees, there will be no real reason to be physically present at a central location as long as they have ready access to data banks and communications systems. Electronic networks will enable workers to stay "plugged in" to the main office while they're at home, at remote branches, or on the road.

TELECOMMUTING

With computer terminals available in the home or at dispersed suburban locations, some employees will not need to come into the main office on a daily basis; some may not need to come in for weeks at a time. This substitution of communications for travel is known as telecommuting.

High-level executives will head for a local branch office once or twice a week instead of making long commuting trips. Some typists will be able to work at home, receiving dictation by telephone or hand-written drafts by facsimile, then returning typed copy via communicating word processors. Handicapped persons who find it difficult to travel will benefit considerably.

MOBILE COMMUNICATIONS LINKS

Two-way radio facilities will be widely available in trains, cars, trucks, taxicabs, buses, and airplanes for individual users. Portable hand-held units will permit subscribers to communicate with other subscribers anywhere in the world--even while traveling. The links will operate via satellite and terrestrial-based networks. Executives will keep in touch with their offices continuously despite being "on the move." These mobile communications links will have long-distance ranges and combine some of the advantages of the citizen's band radio and the telephone.

RADIO PAGING

A radio paging system makes it possible to contact individuals who are not sitting near a telephone. The individual hears a small, inconspicuous radio receiver or "beeper" that can signal with either an alarm tone or a spoken message. The new beepers will be smaller and less expensive and will supply different tone signals so that the subscribers can distinguish between various messages. The caller will be instructed to dial the subscriber's number and then add an extra digit to tell the subscriber whether to call the office, home, or car phone--or proceed directly to the office or some other place.

ELECTRONIC BRIEFCASE

When this portable briefcase--about the size of one today--is open, one side will have a letter-sized screen of plastic across the bottom, equipped with the "touch sensitive" keys and controls of an electronic keyboard. The top two-thirds of the screen will display text, graphics, and video images. All of this will fit in a thin, removable cover. The other side of the case will contain the electronics, the memory slot of pre-programmed chips, and super-batteries to power the unit.

A small phone unit will also be available to communicate with a data network or to dictate material into storage. The rest of the lower part of the case will be empty--providing space for business cards, a sandwich, and extra video, text, or audio memory chips. There will also be a place for sensitized paper for making permanent copies from the screen.

Careers Tomorrow, World Future Society, 1983

Intelligent Communicating Copiers

Intelligent communicating copiers will be available to accept a wide variety of paper stock and perform good quality, rapid printing chores at moderate prices. They will be able to produce color, and enlarge and shrink copies. They will also have the capability to prepare original drafts from data sent by computers and word processors.

Word processors and computers will be connected to photocomposition equipment to eliminate any rekeying of data for volume printing. Inkjet printers will also interface with the word processors and computers. These are non-impact forms of printing where a jet of ink is shaped "electrostatically" to form text. A minimum of operator attention will be required to copy or print attractive brochures, reports, half-tone photographs, pamphlets, booklets, and other message forms.

OPTICAL CHARACTER READERS

Optical character readers (OCRs) will be able to scan a piece of paper, convert the information to digital form, then transfer it to the memory of a computer. Scanning evades keystroking of information and can include supplemental pictorial material. Text editing, facsimile reproduction, storage and retrieval, and printing can then be carried out on the stored information. One application of OCRs will be to scan and route mail and file material by converting paper messages to electronic media.

Communications Tomorrow, World Future Society, 1982

Electronic Mail

An electronic mail system is an alternative to postal service, private carriers, and intercompany mail delivery networks that carry mail physically. It transmits messages (letters, memos, contracts, voicegrams, mailgrams, telegrams) via an electronic communications network (telephone, wire, radio, cable TV, satellite). The system may incorporate various kinds of equipment, including message terminals, small computers, intelligent copiers, and word processors. There are essentially four variations of electronic mail.

1. **Common carrier-based systems and public postal services** are likely to provide document distribution. The U.S. Postal Service and private common carriers will probably offer next-day delivery through a domestic electronic message service.

2. **Facsimile systems** involve scanning a document in one location, converting that information into electronic pulses, and transmitting the pulses over a telephone line to a facsimile receiver at another location--at fast speeds--to reproduce the document.

3. **Personalized computer-based message systems** permit the user to access his incoming messages at his convenience, to dispose of them electronically, and to file, display, or pass them along as he sees fit.

4. **Communicating word processing systems** are word processors whose output, quality, and speed will be high and will eliminate the need to create hard copy; text will be transmitted just as it appears on a screen, and the systems will communicate with other computers, terminals, and word processors.

All of these variations will offer some, if not most, of the following services:

- Built-in levels of priority and confidentiality.

- Filing messages for later retrieval.

- Chaining messages together.

- Option of hard copy and messages displayed on a screen (soft copy).

- Multiple copies.

- Different type styles.
- Automatically addressing acknowledgements of messages back to original senders.
- Specification of multiple addresses.
- Sealing envelopes.

Communications Tomorrow, World Future Society, 1982

Intelligent Word Processors

Intelligent word processors manipulate, edit, and format text to facilitate the production of typed correspondence and reports. The editing and formatting will be performed via a display screen. Rough drafts and finished text will be printed immediately at high speeds and locally or centrally stored. The word processor will also print documents that are prepared at a remote location and transmitted electronically.

The basic word processor will still contain a microprocessor "memory" and/or optical character recognition equipment, a keyboard, a printer, and a graphic display. Most will also have an interface to a data (computer-communications) network. All will have addresses for sending and receiving material.

Three categories of word processing will still exist:

1. **Stand-alone units with display screens** utilize microcomputers that can store items such as a full-hyphenation dictionary, proportionally space and justify typed or printed material, prepare dunning letters for overdue accounts carrying an itemized list of unpaid items, and automatically prepare and personalize other kinds of letters.

2. **Clustered systems** operate on either a "shared logic" or a "distributed logic" basis. In a "shared logic" system, a central processor or logic unit supports a number of remote input units and output terminals. With "distributed logic" systems, each component is endowed with its own intelligence and can operate semi-independently. Several employees will work simultaneously on a document, using a rich set of text editing and formatting capabilities. Operators will manipulate the files in the data base independently of one another but with a great deal of cross-referencing, if necessary.

3. **Time-shared systems** have remote terminals connected to a service bureau's computer and offer large amounts of storage. The only required investment is the purchase or rental of an appropriate terminal.

Communications Tomorrow, World Future Society, 1982

Personal Desktop Terminals and Work Stations

In the next decade, most managers and other professionals will work with personal desktop computer terminals and well-designed, flexible work stations that make computer processing and data storage resources instantly and interactively available for compiling, interpreting, and analyzing information. They will come in many styles with all types of keyboards, video displays, and input-output media. All will be electronically comparable to the conventional four-drawer file.

Work stations will include software and memory facilities for the storage of both incoming and outgoing documents and correspondence, together with powerful automatic indexing and data management capabilities. Specific documents such as contracts, office reports, and purchase orders will be retrievable within a minute or so.

The equipment will be capable of "information tracking." This tracking entails quick checks into the status of requests for information and, when necessary, automatic reminders to those whose answers are tardy. Similarly, with proper programs, the systems will be able to check the spelling of words, keep a personal telephone directory, and maintain master and individual "calendars" of meetings, appointments, deadlines, and other time-sensitive events.

Careers Tomorrow, World Future Society, 1983

Application of Computer Technology

Besides helping freelance writers, the "electronic cottage" can benefit the freelance photographer and other workers who wish to escape the rat race.

When Rohn Engh, a successful photographer in the Midwest, discovered that editors and publishers didn't want to see him--just his pictures--he threw away his alarm clock and appointment books. He and his family have been living on a 120-acre farm in western Wisconsin since 1966. Engh found that his markets followed him and were always as close as his mailbox, though it took some time for the "farmer with a camera" to succeed.

Succeed, he did: Engh's work has appeared in such magazines as Harper's, Woman's Day, Reader's Digest, and The Mother Earth News. Engh began getting more requests for his work than he could handle, so he started a newsletter for other photographers, listing current needs of publishers and other photo buyers across the United States. His Photoletter now reaches some 1,300 photographers in 46 states and five foreign countries.

But Engh's business really took off when he installed a word processor, computer, photocopier, and other electronic devices in his barn, once the home of 10 Holstein milking cows. Engh's Photoletter now has an electronic edition on NewsNet, an on-line database in Bryn Mawr, Pennsylvania. Through this electronic network, a photographer living in a cabin in Moose, Wyoming, can access a publisher's illustration needs and mail a picture instantly, Engh says.

"Within a decade, without doubt, the picture itself will be transmitted conveniently and directly to the publisher 2,000 miles away," Engh says.

Electronic transmission through newly emerging laser and photo-optic technologies will be the preferred delivery system of the future, he predicts.

Engh believes that his existence "in the boondocks" reflects an optimistic future for "free spirits" like himself. "The photo marketer or publisher who chooses to live miles from media centers will find himself utilizing videotapes, microfiche, and viodeodiscs to disseminate and receive images from long distances," he says. And the demand for quality photo illustrations will increase in the visually oriented Information Age.

Careers Tomorrow, World Future Society, 1983

ELECTRONIC BLACKBOARDS

Messages written on electronic blackboards generate digital signals that are clearly, reliably, and quickly transmitted over telephone or other communications lines. An instructor or manager can write on the "pressure-sensitive" surface and thousands of miles away employees will not only be able to hear the lecture but also see what is written on the blackboard via a video screen.

A recorder of some sort can be connected at either end to capture and store the voice. Both voice and associated graphics can be replayed later at times convenient to both the sender and the receiver. Mistakes in writing can be corrected by a special blackboard eraser attached to the blackboard.

COMPUTERIZED TRAINING DEVICES

Smaller electronic units will be plugged into the antenna leads of conventional television sets. These units will contain interchangeable data storage devices along with a microcomputer and will connect with telecommunication links used by the organization. The television set will thus have access to libraries of computer-assisted instruction programs and data banks containing organized knowledge on thousands of topics. Specific programs and data can be selected and displayed on the television screen, including text, graphics, and still and moving pictures.

Careers Tomorrow, World Future Society, 1983

Robots: What Are They?

Generally speaking, a robot is any machine that performs jobs previously assigned to a human being, is self-operating, and is "intelligent"--that is, it contains electronic logic in the form of a microcomputer. A robot must be versatile, a characteristic provided by the microprocessors.

Industrial robots are machines that can be reprogrammed to do a variety of simple repetitive tasks that are usually done by human workers in a factory. Robots can weld, spray paint, cut cloth with lasers, and load and unload materials for other machines.

Robots are a manager's dream: They never take coffee breaks or lunch hours; they willingly work three eight-hour shifts a day; they don't complain about doing unpleasant work; and they never take time off for union meetings. Robots now can do many tasks faster, cheaper, and better than human beings.

Most people think of a robot as something out of Star Wars, an android that walks and talks, sees and feels, and looks much like C3PO or R2D2. Real robots are much more primitive. In its simplest form, a robot is nothing more than a mechanical device that can be programmed to perform some useful act of manipulation or locomotion under automatic control. An industrial robot is a device that can be programmed to move some gripper or tool through space to accomplish a useful industrial task.

Careers Tomorrow, World Future Society, 1983

The Origin of "Robot"

The word "robot" was brought into common usage in the early 1920s by Czech playwright Karel Capek (1890-1938). His 1921 play, R.U.R. (Rossum's Universal Robots) portrays a future society in which chemically-constructed robots (from the Czech word robota, meaning "forced labor") are manufactured to work in factories, releasing humans from the "degradation of labor" and freeing them to live only to perfect themselves.

More than contributing a new word to the language, however, R.U.R. expresses many of the fears and hopes of people confronted with a new technology that promises to turn their lives upside down.

In Capek's play, Rossum's Universal Robots are miracles of engineering; though on the outside they are identical to humans, their simplicity of design enables them to work much more efficiently and cheaply than the "human machine," who is much too complex (from an engineering viewpoint) to be an efficient worker.

When one of the characters points out that the robots will create a great deal of unemployment, R.U.R.'s general manager, Harry Domin, answers that the robot will produce so much food and clothing that everything will be available virtually without price; people will not have to work to buy the things they need.

"Of course, terrible things may happen at first," Domin says, "but that simply can't be avoided. Nobody will get bread at the price of life and hatred. The robots will wash the feet of a beggar and prepare a bed for him in his house."

But Paradise is not to result from robots in Capek's play. As robots spread around the world, govenments turn them into soldiers, and wars become more frequent and widespread.

In an attempt to perfect the robots, the R.U.R. designers give them more intelligence and sophistication. But gradually, as the robots become more humanlike, they turn against humans, killing all but the one who believes in the goodness of physical labor and "works with his hands like the Robots."

In R.U.R., robots are made to look like humans and, gradually, to act like humans. But it is when they are most humanlike that they see themselves as oppressed and begin to rebel. As Domin says, "Nobody can hate man more than man."

Perhaps it is significant, then, that todays's industrial robots are distinctly un-human in their appearance.

Of Men and Machines, Arthur Lewis, 1963

Robots and Loss of Jobs

There are now (1982) only about 5,000 industrial robots in use in the United States, the number having increased by about 30% in 1981 alone. That would represent about 15,000 jobs, but most of those workers have probably been shifted or upgraded, and the number is certainly well within normal attrition rates. The potential market, right now, with currently available robots, is probably between 100,000 and 200,000 sales. Even conservative market projections call for about 50,000 to 70,000 robots in use in the U.S. by 1990.

To put this into context, U.S. industry now employs about eight million "operatives" (blue-collar workers). As a percentage of total employment, the operatives' jobs have been declining for decades. All manufacturing jobs represented 37% of total employment in 1950 and 24% in 1980. Within manufacturing, production jobs--those on the work floor--constituted 82% in 1950 and less than 70% today. More and more Americans are in white-collar jobs.

It is entirely possible that by the year 2000 we could see a million or more robots filling up to three million of today's jobs.

Thus, unless there is some drastic change in the presently projected trends, there won't be enough robots in operation to have a significant impact on overall productivity before the turn of the century.

There is a widespread perception that robots pose a threat to jobs. However, widespread unemployment is not the inevitable result of rapid productivity growth. There is not a fixed amount of work! More work can always be created. All that is needed is a way to meet the payroll. Markets are not saturated. The purchasing power of consumers can always be increased at the same rate that more products flow out of the robot factories.

Careers Tomorrow, World Future Society, 1983

Robotization Proceeding Slowly

Despite the unprecedented economic potential of robots, the implementation of this technology is proceeding slowly for several reasons.

First, at least in the United States, funding for robotics research and development has been very modest. Every indication is that in the future support will grow, but not dramatically. Certainly, there is nothing to suggest that a crash development program on the scale of the Manhattan Project or the Apollo moon program is imminent. The federal government has no plans to launch such an effort, and private investment funds are not likely to be committed on a massive scale because of the long time to payback.

Robotics is still a long-term research topic. We are a long, long way from a sophisticated, sensory-interactive, intelligent, highly skilled, dexterous, economically feasible, and commercially manufacturable robot.

Second, even after the research and development problems are solved, several decades and many hundreds of billions of dollars will be required to convert the present industrial base to robot technology. This enormous investment will severely tax available sources of capital. The transformation of the entire industrial plant of a country can only be achieved over an extended time period.

Third, and perhaps most important, many voters question the desirability of rapid, massive deployment of robots. Despite the obvious benefits, such rapid productivity growth would require serious social and economic adjustments. Productivity improvement by its very nature reduces the amount of human labor needed to produce a given product.

Communications Tomorrow, World Future Society, 1982

College Trustees Almost Cancel Robot Course

HAVERHILL, Mass. -- The fear that robotics threatens American workers' jobs almost caused the governing board of a state junior college here to reject funding for training students in the emerging technology.

Northern Essex Community College was awarded a $54,000 vocational education grant to establish a certificate course in robotics technology, but a motion to accept the funds was initially defeated by a five-to-five vote of the college trustees meeting on Sept. 7.

Trustee James Kelly reportedly argued against the program, charging that robotics is putting people out of work in several industries, such as the automobile industry.

College President John Dimitry asked the board to reconsider the motion, pointing out that 17 students had attended their first class in the program that very morning.

On the second vote the board voted seven to three to accept the grant. One trustee who changed her vote in favor, Carolyn Whittaker, reportedly stressed that she "philosophically" opposes robotics and will not vote to continue the course next year.

The program is funded by $54,000 in U.S. Department of Education funds that are awarded through the state education department. It provides for a 12-month certificate curriculum comprised of several courses focusing on hydraulics, mathematics, programmed devices and the maintenance of robotics equipment.

President Dimitry, in an interview with Computerworld, said the fears of trustees are justified to a degree. Dimitry said he deplores such a situation but realizes that American industry has been built on the continued development of "labor-saving devices."

The college, with a total enrollment of 8,800 students in day and evening divisions, is seeking to promote "computer literacy for everyone, whether they are robotics students or English students," Dimitry said. Some trustees believe the college has placed "too much emphasis" on high technology, he added.

The emphasis may reflect trends in local industry. The college is located in the Merrimack River valley area, which for years has suffered from dependence on the declining textile industry.

In the adjoining town of North Andover is a Western Electric plant employing more than 6,000 people; the Lowell headquarters of Wang

Laboratories, inc. is within easy commuting distance; and Haverhill itself is currently seeking federal funds that would enable Wang to build a plant there.

Despite the cool reception from some trustees, Dimitry said he hopes the course is successful and that the grant will be extended for a second and third year. "Three years ago, some [trustees] used to tell me computers are just a passing fad -- they don't tell me that anymore," he said.

Peter Bartolik
Computerworld, September 26, 1983

Easy to Use Robots

Modern industrial robots are easily programmed. All the programmer need do is guide it through the motions of a task, step by step, and press a program memory button. The robot remembers the process and can repeat it any number of times.

Robots can perform uncomfortable, dangerous jobs. Unlike their human counterparts, robots can handle loads up to 2,000 pounds or work efficiently in temperatures from 40° to 120° F. The die-casting industry, for instance, uses robots because of the danger in walking between the large molds into which molten plastics and metals are poured. Some human workers have lost their lives on the job. But if a robot leaves its arm in the way of a die, it can be repaired or replaced, and a human injury is avoided.

Most industrial robots in use today are hardly recognizable as robots. They do not look like mechanical men but more like pieces of automatic machinery. Usually a robot is simply a mechanical "arm," with two to six joints. The robot's "hand," called an "end effector," can be changed depending on the job. The "hand" can be a welder, a riveter, a paint spray gun, a scoop, or a claw.

Careers Tomorrow, World Future Society, 1983

Lasers Spread Light Most Everywhere

Lasers are an increasingly important branch of the burgeoning high technology industrial market. The term laser is an acronym for a physical phenomenon called light amplification by stimulated electromagnetic radiation. Since their introduction to the market place, lasers have found applications in such diverse fields as communication, medicine, fabrication, metrology (precision measurement) and military functions. All of these applications have been based on the unique narrow bands of frequencies or colors radiated from a laser device and the essentially parallel bundles of energy, and have made use of early, easily controlled lasing media and devices. The applications for lasers are based either upon the ease with which energy of a given color may be transmitted, or the efficiency with which a given color may be absorbed.

The future of laser applications is limited by two considerations: the imagination of the potential user, and the first cost and operating costs of the systems. A great deal of effort is being applied to the cost problems and potential solutions, primarily in industrial research centers. A two-pronged effort is being followed: one, to find some media that are more energy efficient and easier to control, and a second effort to reduce the size of lasing systems through a better understanding of the physics of lasers.

In today's industrial technology the energy efficiency of a laser system is about one to 10 percent. This tends to dictate the use of lasers in special applications for which there is no more efficient process. These applications include: deep eye surgery, precision lead welding, plastic cutting, composite material fabrication, and high speed light modulation for longline data transmission.

The basic research into lasing media and size reduction requires a working knowledge of the rules and practices of solid state physics, with particular emphasis on quantum mechanics and Maxwellian optics as well as conventional macro-optics. When the physicists have completed their work and defined the operating parameters of a given media and system, the engineering staff when is assigned the task of creating a system that will perform a given function.

Traditionally the mechanical engineer has been concerned with structure and the electrical engineer with controls; however, in modern systems they must both be concerned with dynamic stability -- both mechanical and electronic control -- to assure maximum stable and economical system out-put.

Washington Post, September 25, 1983

Japanese Assemble Houses in Four Hours

HOUSTON (UPI) - In Japan, houses are built on a production line in 40 minutes and assembled on an owner's lot in four hours - welded, painted and tacked together with the aid of computers, robots and portable cranes.

"What the Japanese are doing is mindboggling," Doyle Stuckey, president of the Texas Association of Builders, said this week at the National Association of Home Builders convention here.

He said the Japanese gained lessons from their nation's automakers. They not only have incorporated successful techniques such as using robots from the car industry, but also are making extensive use of computers to keep track of an inventory of more than 300,000 items, ranging from screws to insulation to studs, carpeting and wallpaper.

Although Japan has half as many households as the United States, its builders produce nearly the same number of homes per year. The Japanese accomplish this feat in a country a bit larger than California through innovation, marketing, research, and government assistance and intervention, Stuckey said.

Sekisui Heim, one of Japan's top builders, produces 85 percent of its 1-, 2-, and 3-story homes in the factory, where welding, nailing, cutting and gluing are done on a 440-foot assembly line.

A typical house is built in 40 minutes. The entire house is assembled on site in four hours with small crews and potable cranes.

A 1,600-square-foot home with three bedrooms and two baths costs $62,000. Smaller models are available.

"The Japanese buyer, like his U.S. counterpart, selects his own building site and style of house," said Miyawaki Mayumi, an architect for Sekisiui. "Our construction system is the application of high technology to individual design."

Another Japanese firm, Misawa Homes, which builds 20,000 homes a year, has so much confidence in its homes that it guarantees them for 20 years.

The Washington Post, January 19, 1983

Growth of Telecommunications
1850 to 2000

Telecommunications, which is, essentially, the substituting of electrons for paper as the medium of communication, began in the 1850s with the invention of the telegraph. By 1870, the telegraph had captured 10% of all communications revenues in the United States. This transfer from paper to electrons continued with the introduction and spread, in the 1880s and 1890s, of the telephone. By 1900, telephone and telegraph between them accounted for 30% of all U.S. communications revenues. This fraction remained fairly level until the advent of radio, then started climbing again, reaching 45% in 1930.

During World War II, the fraction of U.S. communications revenues captured by telecommunications actually dropped, but bounded upward once more with the arrival of television. Sometime in the late 1950s, telecommunications first captured more than 50% of U.S. communications revenues. Currently, this fraction is over 60%, and, if the historical rate of substitution of electrons for paper is maintained, will reach 75% by the year 2000. Thus, in a century and a half, telecommunications will have risen in economic significance from zero to a commanding three-fourths of all expenditures for communications in the United States.

Communications Tomorrow, World Future Society, 1982

Direct Communication with Animals

Studies of the ways in which animals communicate hold out the promise that some day human beings may be able to exchange thoughts with at least the more intelligent non-human inhabitants of our planet. Sea mammals such as the porpoise and whale whose brains appear to be as highly developed as those of humans could provide humanity with a new outlook on existence, and, in partnership with human researchers, explore the ocean more fully than ever before possible.

Several chimpanzees and at least one gorilla have now been taught the same sign language widely used by the deaf and have learned to express original thoughts by combining gestures in a meaningful way that was not directly imitated from their human "teachers." The range of subtle expression possible through sign language offers the possibility of eventually achieving very sophisticated communication with animals whose vocal chords could not reproduce human speech sounds but whose manual dexterity is as great or greater than a human's.

Koko, the first gorilla to use a human language, converses with her teacher, Francine Patterson, at Stanford University. In six years of intensive training, graduate student Patterson has taught Koko to use and understand a vocabulary of some 375 signs in the American Sign Language of the deaf. Koko uses language to say when she feels "happy" or "sad," and to indicate events in both the past and future. She also makes jokes, talks in rhymes, tells occasional lies to avoid blame, and even invents new words and expressions that accurately describe unfamiliar objects.

Since brain activity and memory in living organisms appear to be a function of minute chemical changes induced by the flow of electricity, it may someday be possible to directly link a human mind with a computer. This might result in "instant learning" of any subject without the need for study or practice. It could also make possible "brain recordings" so that the accumulated knowledge of one individual could be stored in a computer memory and passed on to others at any time in the future. Directly linking the human mind to computer-assisted sensors could enable humans to "see" using any wavelength of the electromagnetic spectrum, or might generate a sense of physical union between man and machine. A pilot, for instance, might become one with his aircraft, thus reducing the reaction time needed to change direction or correct for unexpected problems.

Communications Tomorrow, World Future Society, 1982

Publishing and CAMIS

With an integrated CAMIS system, combining telecommunications and printing-on-demand technology, it will be possible to conduct editing and distributing. Editing and refereeing of manuscripts could be accomplished through an independent Editorial Processing Center (EPC) available on-line on a contract basis. Composing, distributing, and promotion might also be provided by freelance contractors on the computer network, or performed directly by the author using the same system.

- The need for publishers to print fixed quantities of any magazine or book, could end. Instead, bookstores, libraries, and individual subscribers would receive periodic notice of newly available books or articles and could arrange to have copies printed on their own CAMIS equipment, paying only for the items they actually wish to see.
- The expenses of storing, packaging, shipping handling, shelving, and taking inventory of large stocks of printed materials could be virtually eliminated.
- End users of information could custom-make documents, including bound volumes containing the information they need in the particular format most useful to them, regardless of how many other users might want the same information in a different form.

Communications Tomorrow, World Future Society, 1982

Telephones and the Future

LASER TELEPHONE SYSTEM

The Bell System recently began installing the world's largest laser-power telecommunications system. The 611-mile system, which will link phones in the Washington, Philadelphia, New York, and Boston metropolitan areas, is expected to be completed in 1984. "We're entering the age of photonics--carrying communications on pulses of light, rather than as electrical signals," says Richard Jacobsen, vice president of American Telephone and Telegraph Company's Long Lines Department. "Eventually, lightwave communications may offer a high-quality, low-cost way to bring a variety of improved voice, data, and video services to customers in offices, shops, and homes."

TELEPHONE AS MEDIUM OF FUTURE

By 1990 there'll be a billion telephones in the world, nearly all of them direct dial, says Wilson Dizard, a Georgetwon University specialist in international communications. The U.N. is now developing a world telephone which will have 17 digits so you can soon dial any phone in the world just like a local call.

"You can do almost anything through telephone--oral, print, visual," Dizard says. "The computer is very basic. Already in England they are taking the television and the telephone and hooking them into a computer so you can dial the data of your choice such as racing results or weather. The information comes up on your television set and the TV is converted into a computer terminal. It's a universal information system. We really haven't had a period like this since printing developed in the Rennaissance. Computers are going to be the printing presses of the 21st century. We'd better get ready for them."

TELECONFERENCING

Managers and executives spend much of their time in meetings. While the telephone has traditionally been used for two-party conversations, many business meetings involve several people who may be at different locations. Teleconferencing means holding multiparty meetings over communications links connecting two or more sites. The use of the three major forms, including hybrid versions, will increase:

1. **Audio teleconferencing:** The participants communicate by telephone (voice) and sometimes transmit graphic material using special equipment. Individual employees will set up conferences from their own desks without going through an operator, and conferees will talk in normal tones with their hands free, using high-quality "speaker phones."

2. **Computer teleconferencing:** The meeting participants communicate through computer terminals, and their statements and questions are stored in computer memory as a "continuing dialogue." Several individuals can speak (type) simultaneously and they can remain anonymous if desired. Participants in a computer teleconference will not need to be physically available at the same time; instead, they can enter messages on their terminals and read those of other participants at their convenience.

3. **Video teleconferencing:** A large number of remote groups directly communicate with one another through television images with sound. Individuals and groups will see each other on television monitors either in full motion with "zooming capability" or via the "freeze" or "still frame" technique. The moving pictures can be retained on videotapes or videodiscs for later reference and "hard copies" of still frames can be prepared.

Communications Tomorrow, World Future Society, 1982

A New Tool for Decision-Makers

The Consensor, a new computer tool, is making it easier for planners and decision-making groups to find out how much they know and how strongly they feel about alternative choices facing them. The Consensor offers a way to make business meetings and public discussions shorter, more productive, and, at the same time, more democratic and more representative of the participants' true feelings.

INTRODUCING THE CONSENSOR

Physically, the Consensor has three parts: a TV-like display screen, a control console, and a set of individual mini-terminals for each participant. When a question is to be voted on, the meeting chairman activates the Consensor console and clears the display screen. Each person voting then adjusts the two dials on his mini-terminal. He turns one dial to indicate his support or opposition to the issue under discussion and the other to show his degree of expertise or the confidence he has in his own opinion.

To express agreement or disagreement with a proposal, the conference participant turns the bottom dial on his mini-terminal to one of 11 possible settings (zero through 10), with zero indicating the most extreme negative ("complete opposition," "least desirable," "least likely," etc.) and 10 the most positive value ("full agreement," most desirable," "most likely," etc.).

Next, the participant registers the intensity of his conviction--or indicates his level of expertise on the particular topic at hand--by using the upper dial on his mini-terminal. The settings for this "weighting" dial are graduated in five increments--0%, 25%, 50%, 75%, and 100%.

Any setting chosen on the selection dial is counted as a full vote if the weighting dial is set at 100, but only as half a vote if the weighting dial is set at 50. The Consensor automatically records and totals these fractional votes and displays the aggregate weighted position of the group on the TV monitor in the form of a vertical bar graph (histogram). The columns of light on the screen reveal the range of opinions being expressed by the group as a whole, but maintain the anonymity of each individual participant.

Communications Tomorrow, World Future Society, 1982

Users of the Consensor

Such well-known firms as Chase Manhattan Bank, Xerox, AT&T, Du Pont, and Avon are already using the Consensor for strategic planning, budget-setting, personnel-evaluation, and sales estimating. U.S. government agencies have also made use of the Consensor. The Defense Department recently held a Consensor-aided conference among naval officers and technical experts to assess the relative probabilities of alternative developments in future weapons-system technologies. The conclusions reached were included in recommendations on future U.S. military spending priorities. The State Department also held a Consensor conference to analyze policy options and their probable impact on relations between the United States and the People's Republic of China.

Non-profit organizations have also made use of the Consensor. The local United Way Charities of Bridgeport, Connecticut, used a Consensor in a recent series of meetings where they reached agreement on funding levels for 12 fields of service. Two meetings were held with the United Way staff, two meetings with the agencies they support, and two meetings with donor groups. In all cases, the meetings with the Consensor took less time than those conducted in past years without the Consensor, and all achieved results approved by everyone participating.

Uses of the Consensor are not limited to formal meeting situations. The first Congregational Church in Stamford, Connecticut, has used the Consensor to sample reactions to the minister's sermon and to assess the feelings of the congregation as a whole regarding certain fundamental questions of belief. The minister, Reverend Gabe L. Campbell, reported that he feels using the Consensor has helped him serve his congregation more effectively by enabling him to recognize and address issues and concerns that have special meaning for the members of his congregation. People are less willing to discuss their fundamental beliefs than any other aspect of their lives, Campbell explains, but the privacy provided by the Consensor encourages honest expression even in a public forum.

Communications Tomorrow, World Future Society, 1982

Ceefax and Oracle: Electronic Newspapers

Ceefax is owned by the government and BBC, and carries no advertising. Oracle is owned by the Independent Television Authority, expects to earn a profit, and carries advertising.

Ceefax and Oracle make use of two TV lines at the top of a home TV screen which are not seen on a properly working TV set. The Ceefax transmissions are continuous and may be received and read by anyone who has a TV receiver equipped with a decoder.

A "page" of teletext information consists of 24 rows of 40 characters which may be displayed in seven colors. Since headlines take space, the average page is generally 80 to 100 words long.

Each story can run up to four pages with present formatting; so the maximum story length is now about 400 words. There is no technical reason why story length could not be increased if longer articles were desired.

A viewer selects the story he wants to read from an index or from memory by pressing the buttons on a mechanism about the size of a pocket calculator. When he has finished reading one item, he presses the buttons for another subject or another story.

The commercial teletext sets now available are not equipped with printout devices for readers who might want a printed copy. But attachments for such print-out production have been developed and will become available to consumers sometime in the future. Such devices could print advertising coupons that readers could use to order goods.

Readers can choose among 100 different topics within the present 800-page Ceefax format. The topics include headlines, news, people in the news, features, sports, weather, travel, etc.

The entertainment pages show TV programming, film programs and reviews, music and book reviews, information about the theater, and questions and answers from viewers.

Viewers can also get information about food prices, food availability, farm prices, recipes, science news, financial news, police news, and special information on education, farming, and gardening.

Communications Tomorrow, World Future Society, 1982

Television as an Information Utility

Several videotext services are in operation today. Some are electronic newspapers where the viewer is a passive recipient of information displayed on the screen. Others are interactive information retrieval systems where the viewer can request specific information such as stock quotations, weather forecasts, train and airline schedules, or data covering a wide spectrum of other subjects. Videotext comes in two forms--teletext and viewdata.

In a teletext system, information is transmitted over the airwaves to a television set. The viewer can do no more than switch channels to change the information he is viewing, making it the electronic equivalent of turning newspaper pages.

With a viewdata system, however, the viewer has much more direct control over what he sees. Using his calculator-like keypad, he can call for any information stored in the main computer's memory banks; thus, the system is interactive. A viewdata system can make far more information available, but it requires cables or phone lines to allow two-way communications.

The United States has been lagging behind other countries, notably Britain and France, in the development of videotext services.

A British consulting company, Butler Cox, studied the prospects of videotext services in the United States for 37 major U.S. organizations. "Our research has establisned quite clearly that viewdata systems are coming to the countries of the world in one way or another. The commercial pressure mobilized on their behalf will be too great to fail."

Several pioneer programs are already in operation, and they will likely expand. Some U.S. television stations, following Britain's lead, offer closed-captioned broadcasts for the deaf and hard of hearing. A deaf person can pay for an adapter for his television set that will give him captions on the regularly broadcast programs.

Communications Tomorrow, World Future Society, 1982

Electronic Newspaper

Futurists have long speculated that newspapers would someday be delivered electronically to people's homes. In Britain, electronic newspapers are already a reality.

In an American newsroom today, a reporter writes a story on a similar screen and then sends it along its way for paste-up, plating and printing. His English counterpart writes a similar story on a similar screen, but then something different happens if he is using one of the new British "teletext" systems: he presses a button and his words are instantly readable in electronic print on teletext sets all over Great Britain!

The British writer bypasses both printing and delivery. His video display unit is matched by similar VDTs in the homes of his readers, and they can instantaneously read his story. The new teletext technology has changed the picture tube in a living room into an information screen.

"Teletext" is the generic name for three British systems of electronic information delivery -- Ceefax, Oracle, and Viewdata. Teletext is electronic "print" that is readable on a glass screen.

Communications Tomorrow, World Future Society, 1982

Ads of the Future

The impact of videodisc and videotape cassette recordings on commercial television broadcasting is not yet clear. But one means of rapidly lowering the cost to consumers of these new technologies may be to introduce advertising material as part of the pre-packaged programs they will offer. Entire discs or tapes of advertising could even be distributed--as an updated form of Sears Roebuck Catalog--enabling potential buyers to see items demonstrated, or offering them persuasive point-by-point comparisons of different models.

The internationalization of television that could result from the establishment of direct satellite-to-home broadcasting on a large scale would also effect communications for advertising by creating potential new markets of viewers from many different cultural and linguistic backgrounds. To reach these viewers, the TV commercials of tommorrow may be streamlined to eliminate the need for words and background settings as much as possible. Recent experiments suggest that super-short commercials of only 10 seconds or less showing nothing more than a trademark and the close-up of a smiling face can successfully establish the identity of a product and create an association between that product and pleasure in the viewer's mind. This technique could squeeze up to 12 commercials into a two-minute station break.

Communications Tomorrow, World Future Society, 1982

Advent of Two-Way Data Service

MIAMI BEACH - Beginning Tuesday, television viewers here will see a set of lively ads telling them of something about to "change our lives," about a technology that offers "a better way" than newspapers, TV and radio to get information "when you want it."

But no more than 5 percent of them are likely to understand that the excitement is about videotex, most surveys indicate. For South Florida is the site of the nation's first commercial rollout of videotex, the two-way data service that's been the subject of more hype and hope than just about any new consumer technology.

To Norman Morrison, the exuberent executive vice president of Viewdata Corp. of American Inc., the success or failure of the project, being marketed here as Viewtron, will demonstrate nothing less than the direction of home information technology for decades to come.

"We're at the beginning of home information technology," Morrison said. "The whole world is watching South Florida. We are dancing naked on the stage of history. All the manufacturers are waiting. Behind them are all the information providers. Behind them are waiting all the advertising agencies. All they need is a signal."

Morrison and the effort's other planners say they'll know in a year whether they've got a going business or whether the videotex hoopla is nothing more than that. Their goal is to sell, initially for $600 a piece, 5,000 converter boxes to hook up to television sets and small, wireless keypads to enable users to get their news and other information, do their banking and shopping, and even send messages to other system subscribers.

In light of the promotional thrust, it is ironic that the service is being launched here by a firm affiliated with South Florida's dominant newspaper organization, The Miami Herald, through Viewdata, a subsidiary of KnightRidder Newspapers, which owns the Herald, and American Telephone & Telegraph Co. But to the people involved in the project--which has been seven years in the making and will have cost the Knight-Ridder organization between $28 million and $29 million by the end of 1984 between $28 million and $29 million by the end of 1984 (AT&T will not release a figure)--videotex is a natural and inevitable evolution of contemporary information technology. It is, for them, nothing short of a marvel.

In newspaper advertising. Albert J. Gillen, Viewdata's president, likens the videotex introduction to the days "when the first radio crackled its first sounds . . . when the first first came though Bell's telephone or when the first U.S. newspaper came off the press. Few of us actually can say that we were there when history was being made--until now," he wrote.

The Washington Post, October 23, 1983

A Funny Thing is Happening to the Library on its Way to the Future

In the next few years, librarians will increasingly be known as "information scientists"; books will be published on computer tape, and the card catalog so familiar to library users will change into a video display tube. It will all be very confusing to book lovers, but tomorrow's libraries will make information more available and more useful to more people than ever before.

The library used to be a large room filled with book-crammed shelves and presided over by a prim, bespectacled woman charged with enforcing the rule of SILENCE. But all that is changing rapidly thanks to the information explosion and modern technology.

During the next two decades, most libraries will evolve into "information centers." The patrons of these centers will sit at video display units resembling today's television screens. Occassionally, one will murmur with delight at finding just the right citation from a computerized data base. The librarian--or information scientist--will wander about the room giving advice on how to make best use of the data base.

The term data base is still somewhat unfamiliar to people outside the fast growing information field, but it represents one of the most exciting concepts in the new information technology The data base consists of information that can be instantly recalled by anyone sitting at a computer terminal hooked into the system. In human terms, the data base is the system's "memory."

Communications Tomorrow, World Future Society, 1982

Bibliographic Data Bases Provide "Enormous On-Line Knowledge Pool"

On-line bibliographic data bases, another innovation of the electronics revolution, may cause major changes in both library science and research during the 1980s.

These data bases consist of collections of records that can be called up and displayed by a terminal with access to a computer. The records generally include all essential bibliographic information, and they often give a brief abstract of the source. Entries are usually coded by key words so that the user can conveniently conduct an information search.

On-line bibliographic data bases provide a number of advantages over conventional indexes. On-line retrieval is far faster than manual searching, and such speed allows researching. The research worker can use new key words to have the computer give him additional sources. Manual searching takes up too much time to make a full re-search practical. On-line data bases generally offer a far greater number of information sources than the corresponding printed index.

About 70 million bibliographic records are readily available on-line, and nearly 10 million are added each year Allowing for some duplications, about 40 million unique references, with an annual update rate of over 6 million unique references, are potentially at a user's fingertips. While this amount can be matched in hard-copy form by some large libraries, for most libraries it represents a resource pool far larger than anything they could possibly hope to afford as shelf stock, particularly in disciplines not close to their main field. Yet even smaller libraries can have access to this information thorough a computer terminal.

The individual technologies will improve, and in the future will no doubt offer further enhancements: storage in even more compact physical devices, full-text data bases, more reliable telecommunications, improved and more standardized access protocols, better access terminals, routine retrieval via domestic television receivers, and so on.

Communications Tomorrow, World Future Society, 1982

Space and Satellites

By the year 2000, a new system of communicating via space will distribute the benefits of the information revolution around the globe, making productivity jumps possible even in isolated areas of the Third World.

Well before the end of this century, a global revolution will occur in the way people get access to information and communicate with each other. By the 1990s, a new network--the "Skynet 2000" connection--could be in place to provide inexpensive, portable radio links to and from space. A few large, complex space installations will enable a whole continent of nations to install their own terrestrial systems for their own needs under their own control.

Observations from space coupled with communications via space constitute powerful yet economical and practical tools--fast, cheap, and adaptable links to knowledge that is timely, appropriate, and applicable to local needs.

The vantage point of satellites in space gives us access to a world of data--information about such things as weather, crops, resources, land usage, and oceans. Such knowledge can be directed to users all over the world to allow them to act effectively and efficiently.

A combination of three factors will enable the Skynet 2000 network to function:

- **Complexity inversion,** by which large, complex space installations will make small, inexpensive, independent ground units possible.
- **The wired sky,** by which data will be sent across space using laser communications.
- **Computers in space,** by which manned control centers in space will collect data from sensors and data banks and route the information to where it is needed.

COMPLEXITY INVERSION

In the early days of the space program every effort was made to keep any objects being sent into space as small and light as possible, which meant that ground stations needed to be correspondingly large. The Telstar communication satellite, for example, weighed just 150 pounds, but it could relay high-quality signals only to and from such massive ground installations as the 85-foot Goldstone antenna.

As we are willing and able to increase the size and complexity of the space portion of a communications system, however, the corresponding ground units can be small, inexpensive, portable, and therefore widely available. Modern solid-state electronic devices and multibeam antennas allow the space segment to be vastly more capable and complex and yet still stay within reasonable launch-cost limitations--especially in view of the attractive economics of the reusable space shuttle.

With the equation reversed--by sending the complex segment of the technology into space--individuals can receive data from the satellites directly through such simple devices as their television sets or portable pocket telephones. Ground networks such as receiving dishes or wires will be unnecessary. The receiver's location and surrounding terrain will be relatively unimportant.

The principle of complexity inversion allows direct access to space. People will be able to get information from a portable unit not physically connected to anything, without the need for contiguous systems of wires, roads, and mail delivery services.

THE WIRED SKY

Communications companies are now in the process of replacing the copper wires in the ground that carry information by means of electrical impulses with strands of glass that carry information through pulses of light. These optical fibers offer such vastly improved signal-carrying capacity that a single fiber one-fifth the thickness of a human hair can do the work of 10,000 ordinary telephone wires.

Unfortunately, the ground did not come prewired with a fiber optics grid. But, in effect, the sky did. Above the atmosphere, using laser communications, we can make the same multitude of links as if the sky came prewired with an infinite grid of optical fibers.

Using two or more relay satellites, we can communicate vast amounts of data, point-to-point in space. Each relay satellite will have one very large radio-frequency antenna for two-way contact with a profusion of individual earth terminals and several laser antennas for two-way contact with low-, medium-, and high-altitude satellites.

With space-to-space laser transmission, we can have an abundant information flow without exacerbating the overcrowding of scarce radio-frequency wavelengths. Data can be stored in space until it becomes useful to someone; it will be converted to atmosphere-penetrating radio frequencies only upon demand--and then transmitted only where and when it is needed.

COMPUTERS IN SPACE

Space will be a logical place for computers by the late 1980s, when computers will probably have massive capabilities yet be small enough for economical launches. Computers linked with human judgment form an essential ingredient in any information system, and a manned data and control center could provide this function.

A manned computer center would be needed to coordinate the voluminous flow of requests and data. The center personnel would assign the data-collection tasks to the appropriate probes, prepare the operations schedule and programming instructions, receive and store raw data, process requests, and route the data to the requester through the Skynet 2000 connection. This control center would not duplicate other data banks, such as the National Geodetic Survey or the Library of Congress, but would transfer a user's inquiry to the appropriate source.

Certain types of sensor data--such as crop surveys, ice patrol reports, and ocean traffic--would be kept current on a scheduled basis. Other kinds of data would be required for unique or special events, such as disaster measurement and relief operations, location of fish migrations, and mineral surveys.

A person with a computer at any one point in space can, in effect, be everywhere. Through the use of laser communications, a human at a central space station can see, feel, and act nearly as if he or she were actually stationed inside a distant unmanned satellite. For example, a person at a space station can move a lever and direct the maneuvers of an "arm" 22,000 miles away on a satellite. Advances in the technology of information processing and transmission, coupled with sensors and actuators (electronic devices that can activate a remote mechanism), are generating dramatic improvements in the state-of-the-art of robotics and teleoperators.

Communications Tomorrow, World Future Society, 1982

Communication Satellites

Experiments in the early 1960s proved that it was feasible to place a satellite into a synchronous orbit so that it appears to remain stationary 22,300 miles above one point on the earth. A radio signal takes only one-eighth of a second to cover this distance, and, because of the satellite's fixed position with respect to the ground, no expensive tracking equipment is needed to keep beamed signals on target. In theory, three satellites placed in orbit over the equator could provide coverage for the entire earth (excluding only the extreme polar regions). But in order to relay many different signals simultaneously, the number of synchronous communications satellites actually needed is much larger.

In his book Future Developments in Telecommunications, computer scientist James Martin suggests that the maximum number of communications satellites that can operate from synchronous orbits over the equator without interfering with each other's transmissions may be as low as 75. Competition among nations for the right to use or rent out this limited "territory" could become a major factor in determining the future of communications.

The first communications satellites were used to relay messages between countries. The International Telecommunications Satellite Organization (INTELSAT) has launched four series of satellites since 1965 to handle the ever-increasing demand for telecommunications services. Although telephone signals presently account for the greatest share of satellite message traffic, the Intelsat system also relays computer data, teletype, facsimile document transmissions, and television signals. Live TV broadcasts of major world events such as the Apollo moon landings, and the Olympic Games of 1972, 1976 and 1980, are among the most spectacular achievements of satellite technology to date.

Communications Tomorrow, World Future Society, 1982

Telecommunications and Satellites

Commercial satellites are used for telecommunications and TV broadcasting. Government satellites gather data for weather forecasting and geophysical studies. Special satellites and the space shuttle are used for conducting scientific experiments.

The premier U.S. company in the field is COMSAT (Washington, D.C.), a private corporation formed in 1963 under a mandate from the President and Congress to develop a global communications satellite system and to promote commercial development of satellite technology. The company provides international communications services to U.S. common carriers through the satellites of the International Telecommunications Satellite Organization (INTELSAT), of which it is the largest shareholder. INTELSAT, composed of 109 member nations, handles two-thirds of the world's transcontinental telecommunications services, via 17 satellites. In the U.S., Comsat leases Comstar satellites to AT&T.

Seventeen U.S. communications satellites are currently in operation. AT&T, RCA, and Western Union each have four; Hughes and Alascom each have one; and Satellite Business Systems (McLean, Va.), a joint venture of IBM, COMSAT, and Aetna, has three.

The FCC has authorized 43 additional communications satellites to be launched between 1983 and 1986. In a typical system, two satellites might be placed in orbit, and a third kept as a spare. Total cost to start up service--satellites plus launch, insurance, and tracking telemetry--could reach $200 million.

A typical satellite costs about $28 million, but the INTELSAT VI will likely cost much more. Hughes Aircraft received a $700 million contract for development and production of five units, with options for 11 more.

Hughes is the main manufacturer of communications satellites. The other major suppliers are RCA and Ford Aerospace and Communications.

New, more powerful satellite transponders will make it possible to transmit directly from satellites to homes, bypassing earth stations. Satellite Television Corp., a COMSAT subsidiary, will begin direct-broadcast satellite (DBS) service in October 1984, using five transponders leased from SBS. Comsat will do the programming itself, functioning as a pay-TV service. Broadcasts can be received with a dish antenna just 2-2 1/2 feet in diameter, making the service feasible for suburban areas not now covered by cable. The hardware for receiving the broadcasts will cost $300-500 initially, but Comsat expects costs to come down. In addition, viewers will pay a monthly service charge.

Communications Tomorrow, World Future Society, 1982

Crop Forecasting by Satellite

Through the use of satellites and computers, farmers are now getting timely intelligence about global crop conditions that enables them to make informed decisions about what, when, and how much to plant--and how much profit to expect.

The collection and dissemination of agricultural data, which used to take days or weeks, can now be accomplished in a few hours by observation satellites and high-speed computers.

The CROPCAST method breaks up the entire globe into 48-kilometer-square units--about the size of an average Midwestern U.S. county.

The CROPCAST method uses a complex physical data base to simulate crop growth from planting to harvest, subtracting production potential lost due to weather vagaries such as droughts, floods, high temperatures, and freezes.

After high-speed computers analyze the crop simulation and satellite monitoring data, the information is available to clients through personal computers within 24-48 hours. To meet the timely information delivery needs of clients, EarthSat developed a computer communication system called "CROP DIALUP."

Scenarious of future weather will be run with crop growth models to provide estimates of production. Given the projected supply and demand, a price forecast will then be issued. The farmer will thus have a choice of what crop to plant and an idea of what income to expect.

Communications Tomorrow, World Future Society, 1982

Key Orbits for Space Facilities

There are three major kinds of orbits that are important for different reasons.

A low-inclination is the easiest to achieve because the space vehicle can be launched in the same direction as the earth's rotation, which gives it greater initial speed. This relatively inexpensive access with heavier payloads makes the orbit desirable for materials research and manufacturing. At an altitude of 160 nautical miles, it provides a closeup look at the earth from various angles, has low radiation exposure for manned operations, and serves as a springboard to geosynchronous orbit.

In a geosynchronous equatorial orbit, a satellite remains above the same point on the equator at all times, thus making it invaluable for communications. The speed of the satellite and its corresponding altitude - approximately 22,000 nautical miles--make it orbit the earth once every 24 hours. Since the earth is rotating at the same rate, the satellite appears stationary.

Polar and sun-synchronous orbits have the advantage of flying over the entire earth at a low altitude (about 160 nautical miles), checking the same areas, usually weekly, so that changes can be readily identified. A slight variation of a polar orbit is one that matches the movement of the earth around the sun so that the ground under the satellite is illuminated by the same sun angle each time the satellite passes over. This precision lighting allows a very accurate discrimination of changes in crops and sea states from week to week.

Communications Tomorrow, World Future Society, 1982

The Question of Genetic Tinkering

Ten years ago biologists first removed genes from one bacterium and inserted then, intact, into another. The advance was greeted with concern as well as jubilation because of the fear that, with this expertise, scientists might one day create new life. Some of the early reseachers suspected that they have opened a Pandora's box, as had atomic physicists just a generation earlier. "Let us not design a technology fit only for a rational, far-sighted, unerring, incorruptible people," biologist Robert Sinsheimer urged the National Academy of Sciences in 1977.

But genetic research proliferated, blossoming into the promising biotechnology industry. This new industry has never been regulated, and in 1982 stringent proscriptions governing university research were eased as well. Today scientists are closer to realizing some of the feats that sparked the initial hopes and fears. Within a few years they may well be able to cure genetic diseases--the first step toward permanently altering our own inheritable genetic makeup. While many scientific questions have been answered in the past decade, the larger question still remains of whether such changes will be made before we, as a society, fully understand their implications.

The basic technique behind this work, known as gene splicing, was invented in 1973. By switching genes from one organism to another, even to a different species, scientists gained their first serious glimpse into the operation of cells more complex than the viruses and bacteria they had worked with until then.

The first applications of genetic engineering have only begun to reach the general market--products such as human insulin or vaccines that were created not from vats of chemicals but inside doctored bacteria. In a quite different application, still a long way down the road, scientists could improve a crop by giving it new genes to raise its yield or to confer resistance to disease. Plant breeders, of course, have been doing this for centuries, but their methods take time and are confined to the particular traits that each crop species carries with its genes. Genetic engineers, however, would be able to pick genes from a wide range of plants and make far more radical changes.

Perhaps the ultimate form of genetic engineering is its application to people. It is on this issue that many fears remain focused. Humans suffer from numerous genetic diseases; in theory, some of these could be cured by replacing defective genes with healthy ones. Particular attention is being given to blood diseases such as thalassemia and sickle-cell anemia. People with these diseases suffer because their genes create an abnormality in their red blood cells. Researchers hope to be able to extract bone marrow where red blood cells are formed, and insert the correct blood-forming genes. The marrow cells then would be reimplanted in order to produce healthy blood cells.

It may be several years before gene therapy, as such an operation is called, will be available. But the first such experiment has already been tried by Martin Cline, of the University of California at Los Angeles, who hoped to correct the genetic defects of a type of thalassemia in two patients. Because Cline did not first obtain permission from the committees that oversee such work, he was censured by the government and lost several of his grants. His work, though criticized as premature, nevertheless outlined the path ahead.

Like any other medical intervention, a successful gene-therapy operation would cure a disease. However, the patients would still be capable of transmitting the disease to their children. A more radical procedure would be to modify not the bone marrow cells but the patient's sex cells. A new gene inserted into the egg or sperm cells could obliterate a genetic disease that once was passed from generation to generation. This would be a giant stride toward eliminating a major source of human suffering, but it would open the door to actual genetic engineering of the species.

Once we permit inheritable changes for medical purposes, it may be difficult to veto them for other reasons, such as improving brains, brawn, or beauty. We still do not know to what extent many human qualities, especially those of personality, are shaped by genes and how much by environment. Quite probably environment plays a larger role, say in shaping intelligence, than is generally thought. But genes set the general framework on which the environment acts, and tampering with this framework may profoundly change a person's character.

Last June a diverse group of church leaders concerned about the unpredictable potential of this work called for a ban on making inheritable changes in human genes. Their apprehension is well founded, even if the proscription is perhaps premature. Much depends on the form in which the technology develops. Suppose that guaranteeing that your child have heartthrob looks were as difficult a technique as artificial insemination. Probably few people would take advantage of it. But if genetic enhancements came in packages as marketable as pharmaceuticals, their use could noticeably change the human gene pool.

The clerical leaders are probably right in thinking that the only way to prevent wide-scale changes is to forbid any such work. But for Western societies dedicated to the idea of economic progress through technological advance, closing off an avenue of exploration would be a serious step. In a debate over whether or not to go ahead with a new technology, the advantage usually lies with the advocates, since the benefits seem real and immediate, the drawbacks conjectural and distant. New technologies are embraced in the hope that they can be controlled and their side effects mitigated. Thus herbicides such as Agent Orange, the potent asbestos fiber, and drugs such as thalidomide were widely used before their true nature was known. Nuclear power plants are being spread around the world, accompanied by diplomatic attempts to persuade countries not to divert the material and know-how into nuclear weapons.

In the long run, controlling nuclear proliferation is clearly a losing battle. Human genetic engineering, it may be hoped, will provide a more benign technology. Only with convincing evidence that it is getting out of hand will it make sense to forego the undoubted benefits of the technique.

Therefore, close watch should be kept by the press, public and legislators. As the capabilities of genetic engineering grow, they will pose hard choices that cannot be decided only by those working in the field. It is natural for scientists to resist outside interference in their research techniques, and entrepreneurs have obvious financial interests in pushing ahead with minimal regulation, pooh-poohing all suggestions of risk. Because most experts in the field are interested parties, the public may be left in the difficult situation of having to decide about a complicated issue with little guidance.

A lingering belief that living things are immutable perhaps contributes to the present calm about genetic engineering. But all organisms, science tells us, are completely subject to the laws of physics and chemistry. If that is so, there is no limit on the changes and adaptations that can be engineered once the system is fully understood.

In wondering what new life forms researchers may try to create, even the richest imagination is a poor guide. Perhaps it will prove possible to recreate extinct forms of life from the genes of their living descendants. Eventually, it will be possible to design new genes. Or imagine using genetic engineering to make something "useful" out of a monkey: First make the animal larger and strong enough to perform household chores, then increase its intelligence a little (since the DNA of man and monkey probably differs by only a few percent, that won't be a major undertaking). So now we have robust, obedient creatures capable of performing simple domestic tasks but too dumb, we hope, to expect wages in return.

Would such creatures have rights? What about the human workers they would displace upon entering the labor force? We walk into a thicket of problems by creating any subrace of humans, either intentionally or inadvertently. As for a superrace, the concept has been made abhorrent by its history and will probably remain so, for any society that considers it already has enough inequities. On the other hand, human nature is not so perfect that it could not be improved upon.

For three billion years life on earth has been shaped by the force of evolution. We have at last discovered the tools to shape this rich clay to our purposes. The crux of the problem is that we ourselves are part of the clay that we now presume to mold.

It is easy to insist that these issues are too speculative to worry about. In fact, such developments are all but inevitable; the only question is whether they will happen in 10 years or in 100. At either extreme, they are worth considering now, because a technology is never more malleable than at its beginning, when the ground rules are being laid down and vested interests have not yet accreted around them. If the proponents of nuclear power had decided right at the start to put safety first, they might have created a viable industry. The proponents of genetic engineering should not let near-term gains, such as profits and research goals, outweight long-term risks if they wish their craft to enjoy a long run.

Nicholas Wade
Technology Illustrated, November 1983.

What if People Lived as Long as Trees?

Doctors like to say that 99 percent of all the discoveries in the history of medical science have been made in the 20th century, a claim that's probably true. Run down a list of diseases cured in the 20th century and you have an index to illnesses that routinely devastated the human race, diseases that killed millions of our ancestors before they ever reached old age. Yellow fever, scurvy, cholera, malaria, diphtheria, polio, meningitis, tuberculosis and smallpox, to name but a few. If there is one meaningful statistic about where 20th century medicine has taken us, it's the one triggered by penicillin and all its descendent antibiotics. In 1940, infection caused 25 percent of all deaths. Today, it's less than three percent. There's another meaningful statistic that proves the same point. Man's life span was 48 years at the start of the 20th century. Today, it's 72 years.

The fast pace set in the first two-thirds of the 20th century for new cures and treatments will be hard to sustain but it will be done and even stepped up in fields like brain research, which are only now beginning to catch fire. So rapid will be the pace that children being born today can expect to live for 83 years, 10 years more than their parents, 20 years more than their grandparents, and 30 years more than their great-grandparents.

There will be new drugs that lessen the need for radical heart surgery, artificial body parts that prolong the good health of vital organs and artificial organs that prolong life itself. People will not only live to be older, they'll enjoy more of their old age. There will be drugs that improve and even restore memory. They will come in nasal sprays and be so effective they'll set senility back 10 years. Nonaddictive painkillers will appear that are stronger than morphine, mood modifiers will come onto the market that not only elevate spirits but exhilarate them.

GENE SPLICING

Striving to create a man with a bigger brain may be a long way off but striving to conquer disease through genetic engineering is here and now. It's called gene splicing and here's how it works. Take the section of DNA that orders the human body to produce insulin to chew up excess body sugar. Splice that section of DNA into a plasmid, then implant the plasmid into a bacterium where it reproduces each time the "bug" divides.

The idea is to implant the human gene that produces insulin into a microorganism that replicates rapidly. In 30 minutes, the bug divides and both microbes contain the gene that makes insulin. Another half-hour and the two bugs divide again. Soon, there are eight, then 16, then 32. In two days, one microorganism reproduces billions of copies of itself, except that now they're all producing insulin. This is no flight of fancy. Bacteria given the DNA codes to produce insulin have done just that at a fraction of the cost it takes to produce insulin the nongenetic way.

The drug factories of the future will be bacterial factories where the bacteria are implanted with spliced human genes. Besides insulin, the candidates for bacterial production include cortisone to treat arthritis, the antihemophilia fractions of the blood now taken from blood donors and the growth hormone used to treat dwarfism that is now taken expensively from cadavers. The list of diseases that can be alleviated by gene splicing is staggering. People suffering from inherited genetic disease may someday undergo gene therapy, in which an abnormal gene is removed or "turned off" and a normal gene spliced in to take its place. Genetic diseases are among the most burdensome afflictions facing contemporary society. An estimated 12 million Americans suffer from one of the 2,000 disorders of the genes and chromosomes. Huntington's disease, sickle cell anemia and Tay-Sachs disease are among the worst of the genetic killers that may be eliminated by gene splicing in the next 20 years. Hemophilia is a genetic disease. So is Down's syndrome (mongolism), which is passed on to one out of 40 infants born to women over 40 years of age. The time may soon come when the number of persons disabled or killed by genetic disease begins to shrink dramatically.

MEDICINE IN SPACE

Medicine will venture into outer space in the search for new cures and treatments in the years ahead. First to place an experiment aboard the space shuttle will be Johnson & Johnson, which wants to know what the weightlessness of space will do for the manufacture of serums and vaccines. Oil and water will mix in zero gravity. Liquids that can't be separated on earth will separate out in zero gravity. At the very least, completely pure and uncontaminated vaccines made in space will revolutionize the treatment of disease.

The fifth operational flight of the space shuttle in the fall of 1983 will carry a cannister built by McDonnel-Douglas for Johnson & Johnson that will be filled with human blood. By use of a process called electrophoresis, which separates liquids whose electrical charges are different, the cannister, when it is returned to earth, will contain a vial of pancreatic beta cells to treat diabetes and a vial of an anticoagulant to dissolve blood clots. Johnson & Johnson has reserved space on eight shuttle flights through 1985 to experiment with other serums. If the experiments work, they plan to send a five-ton satellite into space that will serve as the first robot pharmaceutical laboratory in weightlessness. Six months later, Johnson & Johnson will pick up the satellite and bring it home to earth, where they will market whatever serums and vaccines were made aboard the satellite. There will be more than new serums and vaccines tested in space by such companies as Johnson & Johnson, Eli Lilly, Merck and Pfizer. On an upcoming flight of the space shuttle, an astronaut will wear a sticky, dime-size patch behind his ear that contains three days' worth of a prescription drug called scopolamine used to treat motion sickness. The drug seeps off the patch into the body in minute amounts that provide a continuous form of treatment. The sky isn't the limit for these skin patches. They'll be tested as a way to administer drugs to treat asthma, high blood pressure and angina.

ASSEMBLY-LINE INTERFERON

The first big benefit of gene splicing will come from its use in producing an ample world supply of interferon, the natural protein the human body produces to fight off viral infections. Doctors have long known that patients with one viral illness also never caught a second viral infection of that particular type, as if the first virus prevents infection by the second. In 1957, two doctors in London found that the body produced a protein in response to a virus attack that made subsequent cells immune to attacks of the same virus. They named the protein interferon, because of the way it interfered with virus infections and blocked the passage of the virus from an infected cell to a healthy cell. They had discovered the body's natural mechanism for immunizing itself against every virus from influenza to the common cold.

They why isn't interferon being used to help the body fight these viral illnesses? For the simple reason that there has never been enough of it to test in clinical trials, let alone to prescribe it for everyday use. White blood cells, the main source of interferon in the body, produce the protein in infinitesimal amounts. What's more, interferon works only in the animals that make it. Only human interferon works in humans, a condition that will be academic in the years ahead because of the miracle of gene splicing. Already, the gene that tells the body to make interferon has been identified and implanted in rapidly multiplying bacteria. Assembly-line production of interferon is right around the corner. Its use against every form of viral attack from hepatitis to some forms of cancer is less than 10 years away.

Gene splicing is such a promising method of making new remedies and new cures that doctors can hardly decide where to start and what to work on first. They talk of new vaccines to ward off infections before they invade the body, new antibodies to fight infections that do invade the body and new antibiotics to kill infections that spread through the body. Vaccines will be made by gene splicing for such intractable viral and parasitic diseases as amoebic dysentery, trachoma, hepatitis and malaria. One gene-splicing laboratory in the Midwest is on the verge of a vaccine that prevents foot-and-mouth disease in animals, an ailment that costs U.S. cattlemen alone more than $200 million a year. At the same time the foot-and-mouth disease vaccine becomes available, look for the first gene-spliced hormones to come out of the laboratory. Medical researchers predict great things for engineered hormones. Of the 48 human hormones identified as likely candidates for gene splicing, 38 are not used in medical practice because they have not been availabe in large enough quantities to be tested for their therapeutic use. Gene splicing will change that overnight.

Widespread use of interferon to fight viruses will spearhead a new chemical attack on disease that will lengthen the life spans of everybody growing up today. There will be new drugs to dissolve blood clots that clog arteries and cause heart attacks. There will be new drugs to halt the secretion of stomach acids that cause ulcers. There will be new drugs that dissolve gallstones and new drugs that prevent the buildup of cholesterol and glycerides that harden arteries and new drugs that flush the arteries clean like chemical roto-rooters. There is already a drug called a calcium blocker that lowers blood pressure, raises cardiac output and cuts down irregular heartbeat all at the same time. There is another drug called a beta blocker that slows the heart and diminishes its need for oxygen when it is struggling to pump blood.

Encounters with the Future, Marvin Cetron

MODULE 2
HIGH TECHNOLOGY REVIEW

EXERCISE MATERIALS

High Technology Exercise

"You Better Believe It"

You are a TV team of reporters from the program "You Better Believe It." You are preparing to give a "Sixty Minutes" type of report on high technology. The information for your report is contained in your Information Package. Also use your own experience and encounters with high technology as a BAT representative.

You can choose any format such as interviews, man-on-the-street, illustrative skits, comedy, etc. Use whatever communication device you feel will be most effective in communicating ten interesting and important facts about high technology. You will have ten minutes for your presentation.

SUGGESTED STEPS

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1. Locate the high technology information package assigned to your group.

    PACKAGE A: page 87 to 94 of the Participant Handbook
    PACKAGE B: page 95 to 102 of the Participant Handbook
    PACKAGE C: page 103 to 110 of the Participant Handbook
    PACKAGE D: page 111 to 118 of the Participant Handbook

2. Individually review the articles in your package for five minutes.

3. As a group discuss the articles and select ten key points you want to communicate as a TV team of reporters.

4. Develop a ten minute presentation which you will conduct for the total group. Decide materials you will use, roles, spokesperson, blackboard, etc.

5. Conduct a dry run of your presentation so that you will be ready to go on camera when you return to the class.

TEN KEY POINTS TO COMMUNICATE IN OUR T.V. PRESENTATION ON THE PROGRAM "YOU BETTER BELIEVE IT."

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

High Tech information Packages

1. Computers and High Technology
2. Factories of the Future and Robots
3. Communications and High Technology
4. Biotechnology

High Tech Information Package A

Computers and High Technology

- Four Generations of Computers
- Microcomputers that Talk and Hear
- Computers: How Do They Work?
- A Revolution in your Hand

Four Generation of Computers

The four generations all work on exactly the same principle: reducing complex problems to a series of yes-no decisions, each tied to an electrical switch. The difference between one generation and the next lies in what kind of switches are used.

The first generation used vacuum tubes. The ENIAC (Electronic Numerical Integrator and Calculator), built in the 1940s at the University of Pennsylvania, had 18,000 tubes. According to legend, when ENIAC was turned on, it briefly dimmed the lights of Philadelphia (a myth, but the machine did use many times more electricity than a modern computer). Yet if any tube failed, the computer made mistakes.

The second generation used transistors, which were far smaller and more efficient. The TX-0, the first transistor computer, worked twice as fast as the ENIAC and had only a handful of failures in its decade-long career. It was only a fraction the size of ENIAC.

In the third generation, scientists combined dozens of transistors on thumb-nail-size wafers called integrated circuits. These were the heart of the computers that guided Neil Armstrong to the moon.

The fourth generation began in the early 1970s, when engineers learned how to etch thousands of transistors onto a single "chip" the size of a match head. Today a $1,000 personal computer works many times faster than its multi-million-dollar forebears, using less electricity than a toaster.

Colossus was the world's first working electronic computer (running two years before ENIAC). It remained a secret until well after the war, by which time its builders had dismantled it. Where the parts had gone was a mystery. Built by the British, Colossus had 1,500 vacuum tubes and an electric eye that read characters off a paper tape. It read so quickly that to touch the tape as it whizzed over the pulleys meant risking a serious wound.

Communications Tomorrow, World Future Society, 1982

Microcomputers that Talk and Hear

More and more people are talking to machines, and the machines are talking back. All the microelectronic circuitry necessary to simulate human speech can be contained on one to three silicon chips, though a tradeoff must be made between the quality of the sound produced and the size of the vocabulary of the "talking chips."

The most renowned product is the single-circuit voice synthesizer patented by Texas Instruments and utilized in TI's educational toy, Speak and Spell. The product can store over 200 words in its memory and pronounce them clearly. The machine speaks a word, and the child tries to spell it by typing it on a keyboard. If the child fails to spell the word correctly, the machine says, "That is incorrect," and spells it correctly.

Microchips "talk" in several different ways. One method of speech synthesis involves storing the sound wave form and volume of a word on a microchip. When the word should be spoken, the memory converts its information to voltages, which are fed to an amplifier.

A second method, called formant synthesis or phoneme coding, stores all the phonemes (building-block sounds of language) necessary for the words to be spoken. The computer then assembles the phonemes in the necessary order. This system requires a lower number of bits per word for storage, but the quality of sound is poorer.

Linear predictive coding, which is similar to phoneme coding, produces a higher quality of speech but also requires more bits per word. As with phoneme coding, the microchip stores the basic utterances of human speech, but it also employs a mathematical model of the human vocal tract in order to provide a more realistic transition from one sound to the next, and to alter intonation.

Personal Electronics, Inc., has recently announced a talking wristwatch. The watch uses the linear predictive coding method in order to announce the time. The watch can be set as an alarm, too, waking you up with music, then announcing the time. And if you don't get up within five minutes, the watch uses a stricter tone: "Attention, please. It is now seven hours thirty minutes. Please hurry."

Some industry analysts are predicting that automobiles will soon use speech synthesis to tell the driver if they are running out of gas, low on oil, overheating, or developing other problems.

COMPUTERS WITH EARS

The recognition of human speech is far more complex than synthesizing it. The acoustic features of words vary from speaker to speaker, and will even vary at different times with the same speaker. Furthermore, the computer has difficulty determining where one word ends and another begins. For instance, the computer can't tell the difference between "a head" and "ahead" or between homonyms like "right" and "write."

Despite the complexities, speech-recognition technology already is available in limited form. Usually, the computers understand only a few specific command words and must be "trained" to recognize the voice of a specific person. The IBM Corporation, however, is trying to develop a voice-activated typewriter, which would accept voice dictation, display the printed material on a visual display screen for proofing, and then provide a typed hard copy.

Voice-recognition technology could also be used for security devices. Like fingerprints, everyone has a unique voice-print. Locks of all kinds could be equipped with a voice recognition system that would allow only specific people to open the lock. This "lock" would most likely be far more difficult to "pick" than today's tumbler-based locks. A voice-security system could be employed with electronic funds transfers or with the use of credit cards over the phone. A voice-recognition system can make sure that the person using the credit card is authorized to do so.

The Smart Machines of Tomorrow, Blake Cornish, The Futurist, 1981

Computers: How Do They Work?

The central processing unit and its memory, the program-storage source, the input device, and the output device--make up a computer system.

Within the main box of a computer there is a solid state chip called a central processing unit, or CPU, and its associated memory. The CPU is something like a brain capable of certain tricks but unable to remember what those tricks are. The CPU is jogged into action only when you've loaded a program into the computer's memory.

You load a program into a video-game machine by inserting a game cartridge into a slot in the machine. You program many inexpensive general-purpose computers the same way.

Costlier general-purpose computers are usually loaded from a disk or a cassette tape. Unlike cartridges, disks and tapes can also store information that you have typed into the computer.

You give directions with an input device. The game machine's input device is typically a joystick or perhaps a joystick plus a keypad with numbers on it.

The input device of a general-purpose computer, however, is a keyboard much like a typewriter's but with additional symbols. The keyboard lets you "input" the more detailed information required by complex programs, or write your own programs.

A keyboard comes with the CPU box of all general-purpose computers. Most keyboards look and feel like the keyboard of an electric typewriter. But there are exceptions among the inexpensive computers.

To show you what it's doing, or to ask for additional directions and information, the CPU must be connected to an "output device." The output device for a game machine is an ordinary TV set. Many general-purpose computers can also use the TV set. When used as a working tool, however, computers typically show their stuff on video display terminals, or monitors.

The CPU is tied to the computer's memory. There are two kinds of memory: Read Only Memory, or ROM; and Random Access Memory, or RAM.

Read Only Memory contains the programs built into the computer by the manufacturer. If you think of a computer as a brain, ROM is its innate intelligence. You can't ordinarily change it, add to it, or subtract from it. In some machines. ROM provides the computer with just enough intelligence to do a few simple tasks, such as suggest you load a program with a disk, tape, or cartridge. In others, ROM provides enough intelligence to "understand" programming from a book or magazine.

Random Access Memory is far more important to the user. It's the amount of RAM that usually defines the computer's maximum capacity to receive information and process it efficiently.

Memory is measured in kilobytes, or thousands of bytes. One byte is what it takes to store a single character in memory. So a kilobyte (1K) could contain a document of about 1000 characters (1024, to be precise).

To use a computer, you would normally buy ready-made applications programs stored on a cartridge or a disk.

A cartridge stores programs only, such as a game. It cannot store information you yourself enter into a computer while working with the program, nor can it store the result of the computer's "processing" of that information.

Tape-cassettes and disks are both program and data-storage devices. You can buy a program on a cassette or a disk and later store additional information (information you've entered or the computer has produced) on the same tape or disk or on a blank.

You can store a great deal of information on a single cassette--the equivalent of 100 or more double-spaced pages. Storing, locating, and retrieving that information is much slower and less convenient than disk drives.

Consumer Reports, August 1983

A Revolution in Your Hand

The hand-held electronic calculator has already had substantial impact on American society. For engineers and scientists, it has completely replaced the slide rule. Elementary school teachers have reached an uneasy truce with it. You can even see housewives carrying calculators as they stalk bargains in supermarkets. Strangely enough, though, the biggest changes due to the hand-held calculator may be yet even larger scale. Scientists and engineers will change their approach to solving problems because of the great deal of computing power they can hold in their hands. Engineering practice and engineering education will change to accommodate the new approaches to solving problems.

AID FOR FARMS AND BUSINESSES

But scientists and engineers are not the only people who will benefit from using programmable calculators to carry out sophisticated problem-solving procedures. Businessmen of all kinds, including farmers, will also benefit.

Businesses, whether small or large, share many of the same problems. These problems include selecting proper inventory levels, managing payables and receivables, budgeting cash flow, and deciding on alternative investments. A large firm can afford these problems. The analysts can use some highly sophisticated financial decision-making techniques.

The programmable calculator will make these techniques available to the small businessman, in a form scaled down to the size of his business. The business of farming has lagged behind most others in the use of sophisticated management methods. However, the programmable calculator will change farming, too. Already the Iowa State University Cooperative Extension Service has developed a collection of programs specifically designed for farmers who want to increase the profitability of their farms. One of these programs allows a feed-lot operator to easily determine the cost and time needed to put a given amount of weight on an animal, using a given mixture of feeds. The farmer can then compare the cost with an estimate of the selling price. He can also try variations of feed mix, total feed, and length of feeding to find out what combination will provide the greatest profit.

Communications Tomorrow, World Future Society, 1982

High Tech Information Package B
Factories of the Future and Robots

- CIM: Computer Integrated Manufacturing
- Factory of the Future
- "Smart" Steam Boilers
- Robots and Creation of Jobs
- Robots and Automated Factors

Computer Integrated Manufacturing: CIM

There is a good deal of discussion today about the coming transformation called the "Information Age." Futurists tend to wax poetic about approaching periods of great transformation. I am certain that every age has something to be excited about, but I have to admit that, as I look into this new age, I cannot help but be impressed by the enormity of the change that is being spread before us. It is an incredible smorgasbord. Although the Information Age will produce dramatic changes in all aspects of society, the most significant transformations may be those which occur in industry. Computer-Integrated Manufacturing (CIM) is the embodiment of machine intelligence in manufacturing. By creating intelligent machines and tying them into a highly sophisticated manufacturing system, man will make a quantum leap in his ability to produce goods. He will dramatically alter the economics of manufacturing and provide society with the means to grow and expand, transcending its present values and structure.

We stand at a most unique time in human history. Within our lifetimes we shall witness the end of one age and the birth of another. We are experiencing the end of a great industrial cycle--the end of the Age of Steel and the technologies and social structure associated with it; and we will bear witness to the development of the Age of Information. CIM will require a substantial restructuring of the corporate organization, both functionally and philosophically. The system will require a good deal of decentralized autonomy, accelerating the current shift from the traditional authoritarian hierarchy to more egalitarian forms of decision-making.

CIM will spark a redefinition, perhaps for the second time in man's history, of the nature of work. Blue-collar values that have been established over a century of factory labor will be transformed by the conditions of the new system. A new stratum of workers will be institutionalized between blue- and white-collar groups--I call them "grays." They are the myriad of technical support people essential to the success of the computer-integrated system. Job-security issues and new standards of compensation will present themselves for resolution as CIM evolves. Retraining, job fracturing, leapfrogging, and outsourcing will take on new importance.

There will also be mobility issues to be resolved. Manufacturing could become highly portable. Experts predict the development of general-purpose manufacturing equipment that will perform a wide range of tasks. With this programmable equipment in place, a plant could produce a wide variety of products. Thus, a firm will be able to relocate to another facility by simply transferring its software. This will exacerbate job migration, regional economies, and a host of other issues. Smaller batch breakevens and the ease of "retooling" may make contracted manufacturing the prevalent method of production. It will also bring new competitors.

The World of Work, Howard Didsbury Jr., 1983

Factory of the Future
CAD - CAM

The high tech firm is an octopus with the computer at its heart. In the old industrial system, an army of people performed boring and repetitive jobs both on the line and in the office. The production line was an inhumane and unforgiving taskmaster that was much better suited to the machine. A very sophisticated computer system and intelligent manufacturing equipment have taken over many of the routine functions, freeing people to make decisions and create.

Product design and development was always an art, but now the computer performs the mundane tasks, freeing designers and engineers to make better use of their talents. Computer-Aided Design (CAD) has replaced the need for endless rows of drafting tables and erasers. Designers work with light pens at consoles. The computer makes detailed drawings, debugs designs, and offers alternate suggestions. It also performs stress and reliability testing, minimizing design problems and reducing lead times.

The computer is the master production organizer and coordinator. Computer-Aided Manufacturing (CAM) has meant tying all the various parts of the production process together to take advantage of the computer's speed and accuracy. Design and scheduling changes are quickly coordinated with the entire organization and its outside contacts. Computers facilitate coordination of the entire manufacturing matrix as has never been possible through the human planners, coordinators, managers, programmers, and other support people. The fine-tuned precision of the operation is well beyond the efficiencies of the old hard-tooled line. The high tech factory has changed the way products are made, introducing many exotic materials and fostering the reconceptualization of virtually every product we use.

A visit to a high tech facility is strange for people accustomed to the traditional factory. "Intelligent" machines perform most of the assembly work once done by people. Machines move and whir, products move through the assembly area, the whole thing orchestrated as if by magic. Factories run continuously, producing a variety of high-quality products at greater volume and lower cost. Now most workers are operators, controlling sophisticated systems, using their heads instead of their hands. Operations are very decentralized, with most of the operating and planning decisions made on the shop floor.

The other workers perform an array of servicing, monitoring, and planning tasks that keep the incredible pace of the factory operating smoothly. Mental stress is higher, as an error at this pace means a lot of wasted product or some very expensive down-time. Each cell has a host of support people who attend to various units throughout the facility. Quite a few skilled trades people are employed maintaining machines, modifying the lines, and installing new equipment.

Careers Tomorrow, World Future Society, 1983

"Smart" Steam Boilers Save Energy

Microprocessor controls installed on industrial process steam boilers can save literally millions of dollars in energy costs for energy-intensive industries.

Recent studies by Honeywell's Energy Management Information Center show that the largest energy-consuming industries in Texas can save the equivalent of 2.5 million barrels of oil a year simply by improving the efficiency of industrial boilers with microprocessor controls. Based on 1980 world oil prices, this savings translates into $77 million. New York industry can save about 1 million barrels of oil, or $31.3 million.

The studies, released last spring, are based on data from the U.S. Department of Energy, the U.S. Department of Commerce, Oak Ridge Associated Universities, General Energy Associates, Inc., the National Association of Manufacturers, and Energy Future, the Report of the Harvard Business School Energy Project.

A network of sensors enables microprocessors to monitor and control the fuel and air mix so that the boiler operates at peak efficiency. The fuel-to-air ratio is critical to the efficiency and safety of a boiler: If too much air is fed, the excess heated air is lost through the stack; if not enough air is fed, some fuel will remain unburned--not only an energy waste but also a source of soot, pollution, and a potential explosion. Individual boilers can save anywhere from $100,000 to $2 million annually, depending on the size and type of the boiler.

The cost of installing computerized energy management ranges from $65,000 to $350,000. Payback is typically within one year--or less as the price of energy rises.

Careers Tomorrow, World Future Society, 1983

Robots and Creation of Jobs

Many years, perhaps many decades, will pass before robots can design, manufacture, market, install, program, and repair themselves with little or no human intervention. In the meantime, the manufacture and servicing of robots will produce an enormous demand for mechanical engineers, technicians, computer programmers, electronic designers, and robot installation and repair persons.

A typical industrial robot costs from $30,000 to $80,000 and sometimes more by the time it is installed and operating. This cost means that creating every robot requires from two to four person-years of work somewhere in the economy, and this requirement will grow with the growing robot industry. Robot production will add jobs to the economy about as fast as robot installation takes them away.

The robot industry will probably employ at least as many people as the computer and automobile industries do today.

Converting the world's existing industrial plants from human to robot labor will require many decades and will cost as much as the total existing stock of industrial wealth. This Herculean task will provide employment to millions of workers for seveal generations. For a country like the United States, which has a strong technological base, the world market in robots could easily create twice as many jobs in robot production as will be lost to robot labor. Needless to say, the export of robot systems (as well as products made by them) could have a strong positive effect on the balance of trade and the strength of the dollar on the international market.

Careers Tomorrow, World Future Society, 1983

Robots and Automated Factories

In the totally automated factory of the future, robots will perform most, if not all, of the operations that now require human skills. There will be automatic inventory and tool management and automatic machining, asssembly, finishing, and inspection systems. Automatic factories will even be able to reproduce themselves; that is, automatic factories will make the components for other automatic factories.

Once this occurs, productivity improvements will propagate from generation to generation. Each generation of machines will produce machines less expensive and more sophisticated than themselves. The cost of robots and automatic factories will decline exponentially and may equal the cost/performance record of the computer industry.

For the past 30 years, computing costs have spiraled downward by 20% per year, partly because computers are used to design, construct, and test other computers. Once automatic factories begin to manufacture the components for automatic factories, products may cost only slightly more than the raw materials and energy from which they are made.

The long-range potential of totally automated manufacturing is literally beyond our capacity to predict. It may change every aspect of industrial society. Automatic factories that can operate without human labor and reproduce themselves could lead to an entirely new era in the history of civilization.

THE HARD-HAT ROBOT

During the 1990s, robots will probably enter the construction trades. Under the tutelage of a human mastercraftsman, apprentice robots will carry building materials, lift and position wall and floor panels, cut boards to size, and lay brick, block, and stone.

In the next century, labor-intensive building techniques (using robot labor) may once again become practical. Homes, streets, bridges, gardens, and fountains may be constructed, cut, and assembled by robots.

Eventually, robots will mine the seabed and farm the surfaces of the oceans for food and fuel. And, of course, robots will play a major role in outer space--in the construction of large space structures, in space manufacturing, and in planetary exploration.

Communications Tomorrow, World Future Society, 1982

High Tech Information Package C
Communications and High Technology

- Features of the Post Industrial Age
- Optical Fibers
- CAMIS
- Characteristics of CAMIS
- Libraries of the Future

Features of the Post Industrial Age

In industrial society--America in the middle of the century--man-machine combinations used energy from the natural environment to transform nature into a technical environment. This form of economic activity depended heavily on energy.

But now, in post-industrial society, the major resource is knowledge. Intangibles have replaced tangible material goods as the dominant factor in commercial enterprise, the central assets, and the primary source of wealth and power. A new set of "knowledge industries" is on the rise. They include a vast range of endeavors:

- All aspects of the printing and publishing trades.
- The communications and telecommunications industries--broadcasting, periodicals, journals, libraries, accounting, teleprocessing, word processing, and so forth.
- Communications and knowledge professionals, including journalists, research scientists, engineers, social scientists, and educators on all levels from pre-school to postgaduate and from trade school to on-the-job training. Also included are policy researchers, think-tank workers, and swelling numbers of professionals whose primary contributions are their brains, not their brawn.
- Last, and crucially important, are the companies engaged in the research, manufacture, and distribution of communications equipment--such firms as AT&T, Xerox, IBM, Control Data, RCA, Texas Instruments, and even Exxon (fast becoming a major factor in communications high technology).

Communications Tomorrow, World Future Society, 1982

Optical Fibers

The optical fiber consists of a core strand of transparent glass coated with a different, more reflective glass. A beam of light entering the core glass will travel along it with very little loss of intensity, for wherever the optical fiber bends, the light beam will be reflected off of the surrounding glass coating back into the core. Optical fibers thousands of feet long are already being mass-produced, and fibers several miles or more in length are under development.

Since the principal raw material for making optical fibers is ordinary sand, they will be far less costly to manufacture than today's copper cables. But the most exciting feature of optical fibers is their enormous carrying capacity. Light waves are so short that a great many can be sent through an optical fiber simultaneously. This means that large quantities of information can be transmitted at great speed. In fact, the signal-carrying capacity of optical fibers is so great that a single fiber one-fifth the thickness of a human hair could do the work of 10,000 ordinary telephone wires, or serve as a TV cable transmitting 8,000 different channels at the same time.

Optical fibers, strung together in bundles for easier handling, have already been used to replace copper wire cable in existing telephone and cable TV systems at locations in Atlanta, Chicago and New York, and are likely to become commonplace within the next 10 years. Ultimately, the optical fiber may prove to be the key to bringing a wide range of communications options to the average citizen. Because of their low cost and high capacity for handling information, optical fibers may bring television, voice, and computer data into the homes of the future as easily as telephone service is brought in by copper wires today.

Communications Tomorrow, World Future Society, 1982

CAMIS

Many graphic arts firms already use Computer Assisted Makeup (CAM) technologies such as electronic displays and computers to design, lay out, and assemble pages for printing. The next logical step is the use of an electronic Imaging System (the IS portion of the CAMIS acronym) that will transfer electronically encoded information as it comes from the CAM process and place it directly onto paper or other materials for people to use.

CAMIS technologies already exist, and their growing use in the coming decades may offer the best of both media worlds, by enabling the reproduction and delivery of printed information in the exact form, and at the exact time and place, desired by the information user. The phrase most often used to describe these new capabilities is "printing-on-demand."

Here is how printing-on-demand could help meet the need for up-to-date research reports and documents. Let's assume that you want to research a specific subject area such as evolution. With access to a computer library of digitally-stored documents, and a CAMIS system, you could scan electronically for the information you need, then save the most useful items in printed form for later reference. You might select Scientific American magazine as a key source and command the computer to search its Scientific American file for any articles on evolution. After reviewing the citations selected, you could extend your search by scanning with the computer for related topics and key-word references.

Once the computer has helped you identify articles of interest, it will ask you what format you desire for printed reproduction. Here CAMIS gives you the option to select type font, paper size and kind--even to print out the text in braille. After selecting the appropriate specifications, you can proceed to have the articles printed and bound into a single volume.

Communications Tomorrow, World Future Society, 1982

Characteristics of CAMIS Printing-On-Demand That Distinguish it from Conventional Printing

1. The printing is wholly computer-driven.

2. The style of reproduction can be altered by the user at the time of printing.

3. Information is reproduced only on request at the time it is needed.

4. Printing takes place at the user's location rather than at a centralized facility.

5. Each page of print is an "original" and different papers can be selected for each edition, or even each copy, depending on the user's need.

6. Physical handling of documents is bypassed, reducing or eliminating shipping, inventory, and warehouse costs of traditional printing.

7. No trade-craft skills are required to operate mini-CAMIS (desk-top) or midi-CAMIS (stand-alone) units. However, maxi-CAMIS installations (elaborate printing presses that operate under computer control to produce large editions of magazines or bound books) demand more specialized training to operate than do conventional processes.

8. Documents are never "out of stock" since the electronic master file from which they are printed remains in the computer.

9. Accounting records for printing and distribution are maintained and updated automatically by the computer.

10. CAMIS allows authors, in some cases, to bypass traditional publishers' gatekeeper function by electronically disseminating their own works.

11. Documents can be continually updated--even during a print run--whereas conventionally printed information is locked into a particular text and form before the presses roll.

12. CAMIS printing is more economical for quick, short runs, while conventional printing holds a cost advantage for long runs of high volume requiring centralized quality control.

13. Documents printed on demand can be assembled from parts of other works as a custom package not available by conventional processes.

14. Never-before-seen computer-generated images can be printed by CAMIS technology with a degree of detail that could not be produced in a reasonable period of time or at reasonable cost using traditional methods.

15. The format and content of documents become interwoven on CAMIS; for example, an income tax form for a corporation may be tailored to include only those items relevant for the individual firm producing it.

16. Several different print media can be accessed from a single CAMIS unit; this diversity can increase as CAMIS units become more standardized.

17. Users of documents can actively participate in the authorship of works by responding to many electronically recorded questions that elicit choices of selection, format, etc., based on user interest.

Communications Tomorrow, World Future Society, 1982

Libraries of the Future

Computerized information, interactive TV, and other innovations of the computer revolution may shape the library of the future. But libraries may also be viewed as important storehouses of traditional information, and books will probably dominate the computer terminals.

SELF-EMPLOYED LIBRARIANS

Close to 60% of the graduates of library schools in 2010 will be self-employed or will work out of libraries under contract to small businesses, community groups, city hall, and even individuals willing to pay for special search services. The growth of the information-broker business will be the result of the need to access the mass of information produced, to sort it, and to weigh it for a specific use. Since many reference volumes (encyclopedias, dictionaries, handbooks of all kinds) will be available at home through some variation of videotext, public libraries will have to decide whether or not to compete with private information companies. They will probably choose not to and will divert their energies to the information-poor segments of society, as well as becoming the conservators of the cultural and intellectual record, as they had been before the middle of the nineteenth century.

AUTOMATED INFORMATION

There is little doubt that the use of machine-readable on-line periodical indexes will increase in university, special business, and industrial libraries and research centers. Whether public libraries get into these services on a large scale will depend on the ability to sell the service to users who can pay--students, businessmen, and lawyers seem the likely market.

SPECIALIZATION OF LIBRARIES

Libraries in the twenty-first century will be built to serve the special clienteles developed over the previous two decades--children's libraries, senior citizens' libraries, libraries for community action groups, and multilingual libraries designed to serve ethnic communities.

Communications Tomorrow, World Future Society, 1982

High Tech Information Package D
Biotechnology

- Genetics: Hottest Science of All
- Foreign Genes Survive Plant Generation Gap
- Biotechnology: Only the Beginning of Startling Changes
- Instant Blood Test

Genetics: Hottest Science of All

Called the "hottest science of all," genetic engineering has the potential for making an impact comparable to that of the transistor and computer. Although some of the great expectations of its early days have given way to more realistic appraisals of its achievements and limitations, it has matured rapidly as a discipline and become a fertile field for scientists and other professionals.

A few years ago genetic engineering, or more correctly, biotechnology, was the heady wonderkind of the stock market, with such little-know companies as Genentech and Cetus over-subscribed within hours of going public. Since then smaller biotechnology companies with specialized scientic capabilities have experienced financial difficulties and required refinancing. Standard Oil of California withdrew from a $15 million joint venture with Cetus Corporation for developing a process for commercial manufacture of fructose, a form of sugar found in honey and fruits and vegetables. But for every failure or reorganization of a smaller, under-financed firm in this overcrowded field, several larger companies -- particularly in the food and drug industries -- have emerged, either directly, or through an acquisition or a joint venture. Consequently, the help-wanted pages of such major scientific publications as Science and Nature are today filled with promises of high salaries and freedom for scientific research for genetic engineers. Manpower projections in this field however, are like shifting sands on a beach; they can be washed out to sea by one economic tide.

The cornerstone of genetic engineering is recombinant DNA, or gene splicing. Stated simply, it is the ability to incorporate segments of genetic material, DNA, derived from one organism into the cells of another organism. The donor and recipient may be closely related, as in two strains of yeast or bacteria; or they may be very different, as in a mouse and a bacteria cell. This technology permits scientists, at least potentially, to develop organisms for food and drug production and other purposes (e.g., microorganisms that can digest oil spills in the ocean).

Biologists, particularly molecular biologists, biochemists and bioengineers were prominent in mastering the lab techniques. Now, genetic engineering is moving from pilot stages to possible large-scale production of new types of food and drugs. This creates many new jobs.

Among the drugs produced on an experimental scale are: interferon for treatment of cancer, human insulin for treatment of diabetes, and human growth hormone for dwarfism. All are in clinical trial stages, and none has been approved yet by the Food and Drug Administration for general use. The proteins required for vaccines for foot-and-mouth disease have likewise been produced by genetic engineering techniques in a cooperative arrangement between government and industry.

The demand for chemical engineers, industrial engineers and computer scientists seems certain to increase as industry moves these products from the test tubes and Petri dishes into large vats so that gallons of the desired substance can be fermented. These vats are computer-sensitized, correct temperatures must be maintained, and care must be exerted to make certain that no "foreign" organism invades the mixture. Maintaining these vats will require sophisticated professionals.

Engineers, systems architects, computer specialists, data base managers, chemists, physicists, technicians and mechanics are just a few of the professionals who will be needed in the genetic engineering field. Ads for all of them can be found, with the food, drug and chemical industries as the major sources of employment.

Molecular and other biologists will continue to be needed by universities, but in many cases those jobs will be underwritten by industries. Examples: Hoechst, a West German pharmaceutical firm, has given at least $50-million to Massachusetts General Hospital for support of genetic research; Monsanto has awarded more than $26-million to Washington University Medical School in St. Louis, and $4-million to Rockefeller University in New York for genetic research.

Awards from industry finance jobs for scientists in universities, but the possibility that the schools receiving the money may be pressured into directing their research towards products desired by their industrial donors continues to worry some.

The need for attorneys and other specialists in patent law seems certain to intensify as more genetic engineered products become available.

Finally, there will undoubtedly be a demand for bioethicists and sociologists.

The Washington Post, September 25, 1983

Foreign Genes Survive Plant Generation Gap

Crop researchers have taken a giant step in plant modification by growing whole plants from genetically altered cells. Initially, Monsanto scientistsreported that bacterial genes conferring antibiotic resistance had been transferred into plant cells. The big question was whether or not the new genes would function in whole plants regeneratd from those cells. The team now reports that antibiotic-resistant (but otherwise normal) petunias have been grown from the cells. The crucial next step is to see if the seeds from the new plants also cary the trait. While antibiotic resistance is not an important trait, the findings prove the feasibility of inserting other foreign genes into plants. Robert T. Fraley of the company's molecular biology group cautions that much more information is needed about how genes are actually expressed in plants before valuable new genetic traits--resistance to disease and insects, for example--can be routinely incorporated into crops.

High Technology, July 1983

Biotechnology
Only the Beginning of Startling Changes

The past few years have been exciting ones for biotechnology. Scientists have modified the hereditary characteristics of bacteria so that they can turn out a variety of useful drugs and chemicals. These first products created by biotechnology are now about to go on the market. But as startling as these accomplishments may be scientists believe that they have barely begun to scratch the surface of what can be done in biotechnology.

"There are amazing developments on the horizon," says Peter J. Farley, founder and president of Cetus Corp., the Berkeley (Calif.) genetic engineering company. Progress already is being made toward modifying the genetics of plants, animals, and even humans. Although much of that research is still in the early stages, it promises to have a profound effect on food production, human health, and medical science.

NEW STRAINS

So far, most of the research using recombinant DNA technology has involved the transplanting of animal genes into bacteria. Scientists have produced a number of valuable hormones and potential drugs including insulin, interferon, and human growth hormone. They also have created strains of bacteria that can convert industrial feed-stocks into fructoseand produce alcohol from wood wastes. The products already identified are expected to carve out multibillion-dollar markets by the 1990s.

But many scientists believe that some of the developments still in the laboratory will have an even bigger impact on U.S. business. Modified plants and livestock may revolutionize agriculture over the next 20 years. By using such techniques as cloning and gene splicing, researchers hope to develop varieties of plants that can grow in harsh environments and even produce their own fertilizer. In fact, a race is on to produce new varieties of crop plants that are resistant to certain herbicides. That would make it possible for a farmer to spray a field and kill everything except the crop plant.

"There is no question that agriculture will be a tremendous area [for genetic engineering]," says Phillip A. Sharp, a professor of biology at Massachusetts Institute of Technology.

Steady progress also is being made toward producing livestock more resistant to disease and capable of "super" yields of milk or meat. In January, Jackson Laboratory in Bar Harbor, Me., reported that laboratory mice had been cloned by transplanting cell nuclei into eggs. And in early June scientists at the University of Pennsylvania reported the birth of a calf that had been conceived in a test tube and later implanted in a cow.

Eventually, scientists hope to produce new species of animals. Already they have succeeded in implanting genes from a rabbit into a mouse. Researchers also hope to be able to copy the genetic characteristics of prize animals into identical copies or produce animals that combine the most desirable traits of three or more "parents." Predicts Cetus' Farley: "In 10 or 20 years, we will literally be designing animals to specification."

Similar exciting progress is being made in human medicine. Dr. Martin J. Cline, a professor of medicine at the University California at Los Angeles, has treated hereditary blood disease by injecting human genes into terminally ill patients in Italy and Israel. Although he was reprimanded and may lose some of his research support as a result, Cline believes that such techniques will be used in "limited numbers" in 10 years, and be commonplace by the turn of the century for treating such disease as sickle-cell anemia.

HELPING THE ELDERLY

Human growth hormone produced by bacteria is already being tested to cure dwarfism, and some researchers see a potential use in preventing the muscle wastage that accompanies long hospitalization of elderly patients. And Monsanto Co. and others are exploring animal growthhormones as a way to shorten the time that livestock have to spend on the feedlot. Other labs are experimenting with a group of human proteins that may play an important role in the way the body fights disease, and also with a substance that may hold the key to regenerating lost limbs and organs. Vaccines against malaria, hepatitis, and hoof-and-mouth disease also are under development.

Modified organisms also are likely to play a major role in energy production. Researchers foresee their use in producing gums for enhanced oil recovery, spliting water into hydrogen and oxygen for use as fuel, converting coal into synthetic gas and industrial feedstocks, and converting biomass to fuel. Scientists at the University of Georgia have even identified bacteria that will remove pollution-causing sulfur from crude oil.

Not outside the realm of possibility are computers that would utilize artificial nerves made by bacteria. GTE Laboratories Inc., a Waltham (Mass.) subsidiary of General Telephone & Electornics Corp., is experimenting with polymers modified so they conduct electricity. Such semiconductor materials can be produced by genetically engineered bacteria that "look more and more like nerve endings," believes Paul E. Ritt, vice-president and director of research at GTE Labs. He adds, "I wouldn't bet next week's food money that we get a nerve fiber substitute, but it could very well happen."

Business Week, July 6, 1981

Instant Blood Test

To a physician, a patient's blood sample is a virtual dossier. Analysis of a blood count can help spot various infections, diseases, and even some types of cancer. Usually it is a matter of hours, and sometimes days, before a laboratory returns results from its tests of a blood sample. But now even untrained medical office workers can perform on-the-spot blood tests and get results in minutes, thanks to a newly developed electronic intrument called the QBC Hematology System.

Drs. Robert A. Levine and Stephen C. Wardlaw have devised a diagnostic system that consists of a centrifuge and an incubator for preparing blood samples, and the QBC reader, the key component of the system. The reader is based on mincroprocessor-controlled light sensors. When beamed to the blood sample through filters, the light detects red cells, white cells, and platelets (part of the blood's clotting system). Then the computerized sensors count these components and display a numerical result on digital panels. All a medical technician needs to do is look through the microscope eyepiece and turn a crank to position the blood sample. According to its manufacturer, Becton Dickinson and Company, of Paramus, New Jersey, blood-test analysis with the QBC system takes about 15 minutes.

Technology Illustrated, July, 1983

MODULE 2
HIGH TECHNOLOGY REVIEW

ATR GUIDEBOOK

Computers and High Technology

Four Generations of Computers

1. Vacuum tubes (ENIAC-18,000 tubes)
2. Transistors
3. Integrated circuits
4. Microchips

Computers in the Future

- Will continue to shrink in size
- Will continue to go down in cost
- Computer books in microchip form
- Cash no longer necessary
- Increased leisure time for workers
- Health monitoring
- Will both hear and speak
- Voice recognition
- Programmable calculators

How Computers Work

- Central Processing Unit--the brains of the computer
- Keyboard--input device
- Program--on a disk or cassette tape
- Output device--monitor or T.V. screen
- Read only memory (ROM)--built into the computer
- Random Access Memory (RAM)--computer's capacity to receive and process information
- Bytes/Kilobytes--measures the memory

Factories of the Future and Robots

Application in the World of Work

- Computer Integrated manufacturing (CIM)
- Computer Aided Design (CAD)
- Computer Aided Manufacturing (CAM)
- Computerized energy management
- Electronic blackboards
- The paperless office
- Telecommuting
- Electronic briefcase
- Electronic mail
- Intelligent word processors

Robots

- Machines than can be reprogrammed to do repetitive tasks
- By 1990, 50,000-70,000 robots in the U.S.
- Cost from $30,000-$80,000
- Robotics is long-term research project
- Can perform dangerous jobs
- Used in military--on and off the battlefield

Communications and High Technology

Telecommunications

- Electrons replace paper as the medium for communication
- Began in 1850 with invention of telegraph
- Optical fibers
- Electronic newspapers/videotext
- World telephone system
- Teleconferencing
- Consensor
- CAMIS - telecommunications and printing-on-demand

Knowledge Industries

- Printing and publishing
- Communications and the communication industries
- Communications and knowledge professionals
- Companies that research, manufacture and distribute communications equipment

Space and Satellites

- Skynet 2000--portable radio links to and from space

- Complexity inversion--space system is complex--ground units are portable and expensive

- Space-to-space laser transmission

- Computers in space

- Communications satellites

- Crop forecasting, weather reports

Biotechnology

Genetic Engineering

- Gene splicing
- Cures for genetic diseases
- Creation of drugs
- Crop research
- Synthesize new substances
- Interferon
- Animal growth hormones
- Extended human life
- Creation of new species of plants and animals

MODULE 3
APPRENTICESHIP IN THE 80's

REFERENCE MATERIALS

Uneven Recovery

A rising tide is supposed to lift all ships. But while the nation's rising economic tide has lifted many communities out of recession, others remain firmly stuck on the bottom. Economists say the current recovery, one of the strongest in memory, is also one of the most uneven.

Consider the Golden Triangle of Texas, an area 80 miles east of Houston delineated by the cities of Beaumont, Port Arthur and Orange. The Texas oil industry brought long-term prosperity after it was born here in 1901. But today the refining and offshore-oil-services center remains mired in recession. "I keep hearing about the recovery, but I'm still waiting," says Edward Strouhal, an unemployed pipefitter in Orange, where the unemployment rate has stubbornly hovered above 20% all year.

Now consider Nashua, New Hampshire, a city of 71,000 just north of the Massachusetts border. Twenty years ago, Nashua was a dying mill town; today, the city's 4% unemployment rate is the lowest in the nation. The home of Sanders Associates Inc., a maker of defense electronics, Nashua is thriving on the high tech and defense spending booms. Help wanted signs sprout from once abandoned textile mills, many of them now electronic plants, and industry leaders fret about a coming labor shortage. "You'd have to be dumb not to worry about a 4% unemployment rate," says Sanders President Albert B. Wight.

There are winners and losers in every economic recovery. But the pattern during the current economic expansion might surprise those who simplistically divide the nation into a booming Sun Belt and a dying Frost Belt.

GREAT RESTRUCTURING

"What we're seeing now is a great restructuring of the nation's economy," says Kenneth T. Rosen, a University of California professor who specializes in regional economics. "There's a shift from energy production and mineral extraction to the defense and knowledge industries. That means new opportunities for growth in places like California and the older cities of the Northeast," he says.

Mr. Rosen is bullish on New England, especially Connecticut. "Connecticut is truly the arsenal of the nation," he says, pointing to the state's heavy concentration of light-weapon, helicopter, submarine and jet-engine manufacturers. Indeed, the $5.9 billion in prime defense contracts awarded to Connecticut last year was the fourth-highest total for any state--and the highest per capita of any state. (California, whose $22.6 billion in prime defense contracts was the highest for any state, ranked fifth on a per capita basis.)

Elsewhere in the country, the industrial heartland and parts of the Southeast are bouncing back sharply in typical cyclical recoveries for regions that suffered the most during three years of economic stagnation. Agricultural areas are facing a mixed picture, helped by new government-subsidy programs but hurt by drought and the strong dollar's impact on exports. Economists say the biggest losers in this recovery are the energy-producing regions, including parts of Texas, Louisiana, West Virginia, Oklahoma and Wyoming.

GULF COAST'S PROBLEMS

The continuing recession in energy-dependent areas can be seen in the offshore-oil centers that line the Gulf Coast. With the exception of Lafayette, Louisiana, every metropolitan area on the Gulf Coast from Brownsville, Texas, to Mobile, Alabama, has double-digit unemployment, says Bernard L. Weinstein, assistant director for research and policy of the John Gray Institute at Lamar University in Beaumont. The Gray Institute is attempting to foster economic diversity in a region dominated by the oil industry since the legendary Spindletop field was discovered there in 1901, leading to the creation of Gulf Oil Co. and Texaco, Inc.

"We're trying to wake folks up to the fact that the good times aren't coming back anytime soon--if ever," Mr. Weinstein says. That point was driven home last month when Texaco announced the layoff of between 400 and 500 workers at its sprawling Port Arthur refinery to reduce employment to 3,400. The refinery's employment was 5,000 a year ago. Petrochemical and oil-rig building operations in the Golden Triangle are also deeply depressed.

But good times appear to be back in the industrial Midwest, led by the sharp upturn in auto sales. "Just as the Midwest receives the hardest blows during cyclical downturns, it is also a fairly strong performer during recovery periods, as manufacturing industries regain lost ground," according to a regional analysis published by Citicorp. Still, economists say the Midwest's longer-term prospects aren't so cheerful. "Many of the jobs lost here in recent years won't be restored, due to increasing automation and the relocation of many production facilities," Citicorp says.

One standout performer in the industrial Midwest is Elkhart, Indiana, the recreational-vehicle center. Between May 1982 and May 1983, Elkhart's 8.1% gain in nonagricultural employment ranked it first among 285 metropolitan areas in percentage employment growth. "Elkhart has been able to parlay a 'low-technology' leisure-time industry into a high-growth profile," says Mr. Rosen of the University of California.

Despite Elkhart's success, high tech industries are expected to continue to spur growth in such states as Massachusetts, California and New York. Just as Harvard University and Massachusetts Institute of Technology helped nurture such Boston-area companies as Digital Equipment Corp. and Wang Laboratories Inc., Stanford University and the University of California at Berkeley have been responsible for the emergence of Silicon Valley and the new biotechnology industries.

Spurring growth in New York is a new industrial innovation center at the Rensselaer Polytechnic Institute in Troy, N.Y., established in cooperation with high technology leaders International Business Machines Corp., General Electric Co., Xerox Corp. and Eastman Kodak Co. And New York City's position as the nation's financial center should ensure its continued prosperity.

Economists attribute the relative strength of the New England and Middle Atlantic regions to the painful restructuring of their economies during the 1960s and '70s. "New England and the Middle Atlantic states lost a good deal of what they were capable of losing" during that period, argues Robert Bretzfelder, a regional economist for the Commerce Department's Bureau of Economic Analysis. "As a result, their underlying strengths in such areas as services, R&D and education have come to the fore."

NORTHEAST'S ENERGY

The Northeastern states will also benefit from moderating energy prices during the current economic expansion. Oil prices have stabilized, and cheap new supplies of hydroelectric power from Ontario should help restrain electricity price increases. Moreover, recently discovered oil and gas finds off the coast of Newfoundland should be a boon to the region, economists say, while hurting traditional energy-producing states in the South and the West.

The picture is mixed in the Plains states. "Agriculture should do considerably better this year, but only because of massive infusions of government support," says Marvin Duncan, a vice president and economist at the Federal Reserve Bank of Kansas City. The Kansas City Fed's district includes the Rocky Mountain region, where "the coal business is still pretty much in the doldrums" in such states as Colorado, Wyoming and Montana, he adds.

Still, Lucy Black Creighton, a vice president and economist at IntraWest Bank of Denver, predicts that "by the time this year is out, Colorado will have performed as well as or better than the nation as a whole." High-technology employment continues to increase: Hewlett-Packard Co. has five plants in Colorado, and Colorado-based Storage Technology Corp. has spawned many spinoff firms. Denver continues to benefit by being the region's services center.

Texas and the Southwest are loaded with economic contrasts. Electronics firms in the Dallas-to-San Antonio corridor (nicknamed "Silicon Gulch") are thriving, as is Dallas, a financial and services center. But border towns are reeling from the effects of the repeated devaluations of the Mexican peso. And Houston and other energy centers are hurting.

"Houston will be the five-star loser city in this recovery," predicts California's Mr. Rosen. "It is dramatically overbuilt, and its infrastructure is terribly inadequate." The city lost 100,000 jobs last year, and even people who are gainfully employed are thinking of leaving. Steven McCabe, a 30-year-old accountant, moved to Houston from Ohio in 1980, chasing the energy boom. "The job market was so good. Now, things are stagnating. It's very difficult to change jobs to get ahead," he says, adding that he wants to move to Boston.

Prospects for a strong recovery in the lumber and aerospace-dependent Pacific Northwest were dampened by the recent firming of interest rates and continued weak airline profits. But California, the nation's most populous state, is booming. The state gained 166,000 jobs in June--roughly four times the expected monthly gain during a recovery period, says Bank of America economist Robert Hess. Total employment in the state is the highest it has ever been, he adds.

California should continue to outpace the nation during the recovery, many economists say. "We're only now seeing the beginning of the big defense buildup," says Wells Fargo bank economist Joseph Wahed, who predicts that defense contracts in the state will climb to $30 billion by next year, from $22.6 billion in 1982. Housing, tourism, agriculture, foreign trade and high technology manufacturing are all either recovering or poised for recovery, he adds. "Diversification remains one of California's great strengths," he says.

NASHUA'S GAINS

New England is also expected to continue to boom. The region's industrial transformation is illustrated by Nashua, New Hampshire. "When I was growing up, everybody either worked at the mills or the shoe factories," says Mayor Moe Arel. "My dad worked in a shoe shop and my mom worked in the mills." But the textile mills shut down in the late '40s, victims of cheaper labor in the South, and shoe production slowly but surely moved overseas.

By the early 1950s, Nashua's economic prospects were dim. Then Sprague Electric Co. took over an old mill building and began assembling electronic components there. Sanders Associates followed.

"Cheap real estate and a good work force" were the main attraction, Sanders's President Wight says. Now, Nashua is home to dozens of electronics firms, and its 4% unemployment rate is the envy of the nation.

Economists doubt whether currently depressed areas such as the Golden Triangle of Texas can duplicate Nashua's economic transformation. "We're starting out with highly paid oil-industry workers who have few other skills," says Philip L. Johnson, the executive director of the John Gray Institute in Beaumont. "Finding jobs for them will be a lot more difficult than replacing shoe factories and textile mills in New England."

The Wall Street Journal, September 9, 1983

'High Tech' is No Jobs Panacea, Experts Say

Communities and regions beset by unemployment and a cloudy economic future because of the loss of manufacturing jobs are working diligently to attract companies involved in high technology. But the strategy is unlikely to solve long-term economic problems, according to experts in labor and the workplace.

The experts have three main reasons for their conviction: many more jobs will be lost to industrial layoffs than will be gained in the advanced technology fields in the coming years; the communities that are losing industrial jobs are not likely to be the same ones that attract high technology; and the new jobs generally do not pay nearly so well as the old ones.

Communications, electronics, computers and other areas of high technology have not created as many jobs in the past decade as many observers predicted "and it won't create that many jobs" in coming decades, asserted Jack Metzgar of Roosevelt University in Chicago, a specialist in the impact of computers on society.

Sol C. Chaikin, president of the International Ladies' Garment Workers Union, said, "High tech will never support the number of jobs we are losing."

In labor, business and government, an accelerated push for high technology is generally believed mandatory if American industry is to become more competitive.

Mayors, members of Congress and businesses talk repeatedly of attracting high technology, particularly in the Middle West. Cities like Buffalo, Cleveland and Detroit and states like New York, Ohio, Michigan, Indiana and Illinois are working on strategies to attract sophisticated technologies based on computers and microelectronics.

Almost no experts question the need for new technologies, which offer much promise, including the elimination of much boring or difficult work and the prospect of higher productivity.

Yet most high technology jobs do not demand high skills or pay high wages, several labor and workplace experts said in interviews. Rather, they said many of them are repetitive, tightly supervised jobs with relatively low or moderate pay. A steelworker, for example, could make $12 to $15 an hour in direct wages, while a computer operator often makes little more than the minimum hourly wage of $3.35.

Arthur Shostak, a professor of sociology and a labor authority at Drexel Institute of Technology in Philadelphia, said some high technology work included jobs that offered "exhilarating tasks that are spirit-enlarging and mind-challenging." But he said most high technology jobs were "incredibly mind-stunting, mind-dulling."

Robert Schrank, a private work consultant formerly with the Ford Foundation, said, "Highly skilled people, like a good service engineer, are well paid." But he added, "People who do the menial high tech jobs, like assembly work, where it's just routine work, are paid routine wages."

MANY NEW JOBS LACK SECURITY

Audrey Freedman, labor economist for the Conference Board, the business research organization, said, "high technology is not all high wages, that's for sure."

Many high technology jobs, additionally, often promise little job security, experts said. The jobs, often simple and repetitive, can be easily automated, just as in conventional manufacturing. And the jobs, both manual and automated, can quickly be sent abroad.

"High technology is not a solution to the unemployment problems in manufacturing and the rest of the economy," said Harley Shaiken, a work and technology specialist at the Massachusetts Institute of Technology.

Mr. Metzgar of Roosevelt University said the term high technology had become a metaphor for an economic and workplace transition. But he said the term was "having a devastating effect" on how the nation thought about traditional manufacturing and about workers and communities experiencing industrial change.

SOME FEAR COMPLACENCY

"It's making us think of the future," he said. "It's helping us not understand the problems that face us now. It's making us think we will not have to do anything but sit and arrive at high tech."

Howard D. Samuel, president of the Industrial Union Department of the American Federation of Labor and Congress of Industrial Organizations, which conducted a two-day conference last week on technology and its effect on the workplace, offered similiar views.

He said high technology could be a "snare and an illusion." He said that high technology jobs would "not add up to much in our lifetimes" and that high technology industries could not be expected to behave differently from other industries in such matters as plant closings or transfer of work abroad.

Projections by the Federal Bureau of Labor Statistics support many contentions of the labor and workplace experts.

The bureau has difficulty defining high technology, because it is new and amorphous, said Ronald E. Kutscher, head of the bureau's Office of Economic Growth and Employment Projections.

A computer programmer is regarded by everyone as a high technology worker. But a specialist in a steel plant control room or a railroad locomotive manufacturing plant, working with computer-aided systems, is also a high technology worker, experts said, even though he might not be counted as one. Such factors make totaling high technology jobs difficult, Mr Kutscher said.

Still, the bureau says that from 1972 to 1982, about 600,000 jobs were created in the United States by manufacturers of high-technology products like computers, microprocessors and robots. Mr. Kutscher said five computer-related categories, specifically data entry, programming, operation, system analysis and other specialties, accounted for just 5 percent of the nation's job growth from 1972 to 1982.

MOST NEW JOBS GO ELSEWHERE

He said that with the exception of data entry jobs, such occupations were likely to have high growth in the coming decade. Still, he said, the bureau believes such occupations will account for only 7 to 8 percent of job growth in that time. Private forecasters make similar projections, experts said.

"An awful lot of press has been given to high tech," Mr. Kutscher said. "A lot of job growth will continue to be in traditional occupations, from secretary to truck driver."

Specialists say the recession has hurt high technology industries, limiting employment growth. And the potential is limited, too, they say, because of foreign competition, particularly from the Japanese, and because a major goal of automation is to reduce labor, not expand it.

Moreover, many high technology jobs can be easily exported, as was demonstrated when Atari Inc. announced in February that it would shift the bulk of its manufacturing from California to Hong Kong and Taiwan, idling about 1,700 American workers. Such transfers, both of production and office work, are likely to increase, experts believe.

Mr. Shaiken of M.I.T. said the most important effect of high technology may not be in high technology industries themselves, but "downstream." A company making, say, office automation equipment may not employ a lot of workers, but their products could have profound effects in the places they are used, such as banks, insurance companies and other business offices.

e technology alters the tasks workers are asked to do and often reduces labor needs, he said.

A MOVE FROM INDUSTRIAL AREAS

Experts said they believe that companies specializing in high technology, generally requiring high levels of research and development, will continue to avoid old manufacturing districts and will seek attractive sites near universities where there are enough workers for production needs and no strong union traditions.

For example, many high technology companies have located in such places as along Route 128 near Boston and its many universities, California's so-called Silicon Valley, near Palo Alto, the site of Stanford University, and the Research Triangle area of North Carolina, which includes Duke University and other universities.

"I think many high technology companies would be very shy to go into Michigan, for example, because of the union tradition," said Mr. Schrank, the private consultant. "They're not going to hire a bunch of laid-off members of the United Auto Workers at the minimum wage and then face a union election in six months."

The American workplace has continually been changed by new technologies since the dawn of the Industrial Revolution and inventions like the cotton gin and steam power. What now seems new, experts said, is the speed and dimension of technological change.

High technology also affects many occupations at once, while older technologies often did not, experts said.

Mr. Shostak of Drexel said that, historically, "there have been winners and losers" when new technologies were used. But "this time winning and losing appears more significant," he said because "the magnitude of the loss is much greater."

William Serrin
The New York Times, September 18, 1983

The Real Job Boom is Likely to be Low-Tech

Kevin Thomson, who just turned 19, got his first job working behind the counter at the new Roy Rogers restaurant in Times Square. That was in June. He expected it to be a summer job that would continue on a part-time basis when he returned for his sophomore year at City College.

Instead of going back to college this month, however, Mr. Thomson has decided to enter a 10-week training program to become a manager in the Roy Rogers chain. The fast-food business, he says, has more appeal than college.

More young people may be following a similar route during the 1980's. Despite the attention lavished on employment opportunities in high technology and computers, most jobs available this decade will be decidedly low tech. Reports from the federal government's Bureau of Labor Statistics show the greatest demand--in descending order--will be for secretaries, nurses' aides and orderlies, janitors, sales clerks, cashiers, nurses, truck drivers, fast-food workers, office clerks, waiters and waitresses. Jobs for programmers, systems analysts, operaters, data entry workers and other computer specialists will account for only 5 percent of the employment growth during the 1980's, bureau statistics show.

Meanwhile, 75 percent of all young people today graduate from high school; about 33 percent spend some time in college. For high school and college students, the push for computer literacy is on. But as Herbert Bienstock, director of the Center for Labor and Urban Programs, Research and Analysis at Queens College, noted: "Most jobs in this country require very little in the way of skill development or training." They may require even less computer sophistication. According to a center study released last week, more than 60,000 jobs that can be performed with little or no prior training are available in New York City each year.

THE SERVICE INDUSTRY DOOR

"It doesn't mean we ought to forget education, since education is for living and life, not just for occupations," said Mr. Bienstock, a former New York regional commissioner for the Bureau of Labor Statistics. But it may mean that schools must change the way they prepare young people for the work world.

Experts are not ready to say that swarms of college graduates will become janitors and truck drivers. Nevertheless, "In the last decade, largely because of the increase in college graduates, about one in five degree recipients ended up taking a job that didn't require a college degree," said Ronald E. Kuscher, associate commissioner of the Bureau of Labor Statistics in Washington. The trend, he said, will continue.

Many students without baccalaureat degrees, sometimes without high school diplomas, will enter the job market through service industries. "Increasingly, youngsters are getting their first work experience there, much as people in the old days began in farm jobs," said Gene Bottoms, president of the American Vocational Association. "It is a way of making the transition from school to work." It can also be a launching pad to a career, he said which is why "the educational system has to be concerned with preparing youngsters not only with entrance level skills, but also with the ability to progress up the ladder."

Educators acknowledge that many service jobs have been held in low repute. The key to directing the supply of young people to the demand is to demonstrate that those jobs are a beginning, not an end. "It isn't stimulating for a young person to look forward to a lifetime as a hospital orderly, but if the person sees this as part of a career ladder, as a chance to become a rehabilitation assistant or a respiratory therapist, that's something else," said Sylvia Ballatt, a supervisor for the Board of Education. She is also the former principal of Clara Barton Night School in Brooklyn, where training in the allied health fields virtually assures employment.

Just because a college degree is not needed to perform many of the available jobs does not mean employers will favor the uneducated. Secretaries must be able to spell, waiters must be able to add, truck drivers have to read. In short, basic skills matter. The use of computers may make them matter more as health technicians, for example, use more sophisticated diagnostic tools that have more complex instructions and yield more detailed data. For most young people, then, movement up the career ladder will mean taking continuing education programs.

The attitudes job-seekers bring to the workplace may be as important as their skills. Prodded by employers, schools are paying attention to this kind of preparation. "We know someone can be a waiter or waitress and serve a table, but is that person courteous to customers and cooperative with fellow workers? Does he or she get to work on time? Does the person hae a good attitude?" said George Quarles, who just left as director of vocational education for New York City public schools. The barriers to employment for most students, Mr. Quarles said, "are not that they lack particular skills, but that they do not understand what is expected of them on the job."

The New York Times, September 4, 1983

Computers: Worker Menace?

The characteristic job in the United States in 1990 will be pushing a broom rather than programming a computer, according to a much-discussed report of two Stanford University economics researchers.

The study, written by Prof. Henry M. Levin, director of Stanford's Institute for Research on Eucational Finance and Governance, and Dr. Russell W. Rumberger, the institute's chief research associate, argues that the growth of computers and other forms of high technology serves to decrease the skill level of the average worker.

Using Bureau of Labor Statistics projections and other data, the researchers challenge the arguments made by some government leaders and businessmen that high technology industries will come to dominate the nation's economy and will require an ever more highly-trained work force. The researchers seem equally dubious of the sweeping claims for the importance of high technology made by both President Reagan and the so-called Atari Democrats.

Instead, Dr. Levin and Dr. Rumberger write, "although employment in high technology occupations will increase quickly in percentage terms over this decade, the contributions of these jobs to total employment growth will be quite small." Their report, "The Educational Implications of High Technology," was completed this year with funding from the National Institute of Education.

Of the 20 leading occupations in producing numbers of new jobs, none is related to high technology, the authors write, and only two--teaching and nursing--require a college degree.

In this country, they argue, one danger is that "entire classes of skilled workers will disappear or will be severely reduced in numbers as their jobs are replaced by robots or computer software." As one example, they say, "the wide-spread use of computer-aided design may virtually eliminate the occupation of drafter in the not-too-distant future, a potential loss of 300,000 skilled positions."

Dr. Levin and Dr. Rumberger say that what is happening with the introduction of high technology may resemble the conditions described more than 20 years ago by Prof. James Bright of the Harvard Business School, who found that job skill requirements at first rose with mechanization but they fell sharply. People in the computer industry tend to disagree, saying average workers will be able to expand their job skills.

"My own research confirms their findings," said Harley Shaiken, a research associate in technology and labor analysis at the Massachusetts Institute of Technology. Mr. Shaiken said that his analysis of several companies indicated that there is a growing tendency to see a "two-tier work force" with a small group of creative people at the top and a large work force of people needing relatively low job skills and being paid correspondingly low wages.

The New York Times, Sunday September 4, 1983

New Occupations Forecast

The authors, Marvin Cetron and Thomas O'Toole, anticipate that the following occupations will become increasingly important and forecast the total number of U.S. jobs for each category in 1990. They also suggest what a typical starting salary will be in that year and what the average midrange salary for each occupation will be.

ENERGY TECHNICIAN

1,500,000 jobs. Starting salary, $13,000; average salary, $26,000.

Jobs will explode as new sources of energy become marketable. Demand will greatly exceed available manpower in nuclear power plants; coal shale, and tar sands extraction, processing, and distribution; solar systems manufacturing; installation, and maintenance; synfuels production; biomass facilities operations; and possibly geothermal and ocean thermal energy conversion operations.

Technicians, inspectors, and supervisory positions will require a high-school education and the equivalent of two years of technical college.

HOUSING REHABILITATION TECHNICIAN

1,750,000 jobs. Starting salary, $14,000; average salary, $24,000.

The doubling of world population in the next 35 years will intensify housing demand, leading to mass production of modular housing, employing radically new construction techniques and materials. Modular housing will be fabricated with all heating, electric, waste disposal and recycling, and communications systems pre-installed.

Technicians, inspectors, and supervisors will require a high-school education and the equivalent of two years of technical-college education plus appropriate experience (such as formal apprenticeship).

HAZARDOUS WASTE MANAGEMENT TECHNICIAN

1,500,000 jobs. Starting salary $15,000; average salary, $28,000.

Decades and billions of dollars may be required to clean up cities, industries, air, land, and water. Additionally, tens of thousands of jobs will be added in each area as breeder reactors and coal, shale, and tar sands mining and processing reach commercial stages. When the requirements for collection, transportation, and disposal of radiological, biological, and chemical wastes are included, the total workers needed could well exceed 1.5 million.

Highly specialized technical training of two years will be required for workers, supervisors, and managers in this very hazardous occupation.

INDUSTRIAL LASER PROCESS TECHNICIAN

2,500,000 jobs. Starting salary, $15,000; average salary, $25,000.

Laser manufacturing equipment and process (including robotic factories) will replace many of the machine and foundry tools and equipment. The new equipment, processes, and materials will permit attainment of higher production quality and quantity at lower production costs.

High-school, technical training, retraining requirements will vary with levels of skill required under a severe system of job devolution.

ROBOT TECHNICIANS

1,500,000 jobs. Starting salary, $15,000; average salary, $24,000.

The microprocessor industry will become the third largest industry in the U.S., facilitating extensive use of robots to perform computer-directed "physical" and "mental" functions. Millions of human workers will be displaced. New workers will be needed to insure fail-proof operations of row after row of production robots.

Knowledge and skills requirements will compare with present-day computer programmers and electronics technicians.

MATERIALS UTILIZATION TECHNICIAN

500,000 jobs. Starting salary, $15,000; average salary, $24,000.

Future materials are being engineered and created to replace metals, synthetics, and other production materials not suited for advanced manufacturing technologies. Materials utilization technicians must be trained in working with amorphous and polymer materials and others that may be produced at the molecular level through the process of molecular beam epitaxy, involving atomic crystal growth. In addition, there will be genetically engineered organic materials. These and other "man-made" materials will substitute for natural-element metals and materials now being depleted.

An education level equivalent to that of an electronics technician, tool and die maker, non-destructive materials testing specialist, or industrial inspector will be required. Two years of technical college will be a minimum requirement.

GENETIC ENGINEERING TECHNICIAN

150,000 jobs. Starting salary, $20,000; average salary, $30,000.

Genetically engineered materials will greatly improve upon and supersede present organic materials and will also produce benefical effects upon some inorganic materials processes. These engineered "man-made" materials will find extensive usage in three general fields: industrial products, pharmaceutical, and agricultural products. Completely new and modified materials and substances will be produced under laboratory like conditions and in capacities comparable to industrial mass-production quantities. Technicians must be educated and trained to work under laboratory-type controls without inhibiting production of some of the materials in tonnage lots.

A bachelor's degree in chemistry, biology, or medicine will be helpful in the initial industrial production work, but production operations will be accomplished by "process technicians" with high-school and two-year postsecondary technical education and training.

HOLOGRAPHIC INSPECTION SPECIALIST

200,000 jobs. Starting salary, $20,000; average salary, $28,000.

Completely automated factories will employ optical fibers for sensing light, temperature, pressures, and dimensions and transmitting this information to optical computers that will compare these data with holographic, three-dimensional images stored in the computer. Substantial numbers of inspectors and quality-control staffs will be replaced.

Specialists working in this new technology will require a minimum of two years of postsecondary technical education and training, with emphasis on optical fibers characteristics and transmission, photography, optical physics, and computer programming.

BIONIC-ELECTRONIC TECHNICIAN

200,000 jobs. Starting salary $21,000; average salary, $32,000.

Mechanics will be needed to manufacture the actual bionic appendage--arm, leg, hand, foot--while other specialists work on the highly sophisticated extensions of neuro-sensing mental functions (seeing, hearing, feeling, speaking) and brain-wave control.

These technicians will require appropriate technical knowledge of microprocessors and specialized accredited education in the respective anatomical, physiological, and psychiatric disciplines equivalent to a minimum of four years of college work. Medical professionals who establish a reputation will move into the higher six-figure levels of earnings.

BATTERY TECHNICIAN

250,000 jobs. Starting salary, $12,000; average salary, $18,000.

These technicians will schedule and perform tests and services for new fuel cells and batteries used in vehicles and stationary operations, including residences. Such fuel cells may be charged and discharged by direct electric inputs from conventional electric distribution systems, by solar cells, and by exotic chemicals generating electricty within the cells.

These processes include potential hazards but can be safely serviced by technicians with a vocational high school education.

PARAMEDIC

1,300,000 jobs. Starting salary, $16,000; average salary, $29,000.

Needs for paramedics will increase directly with the growth of the population and its aging. In forthcoming megalopolises and high-density residences, emergency medical treatment will be rendered on the spot with televised diagnoses and instruction from remote emergency medical centers. Despite reports of a forthcoming glut of doctors, they and other medical specialists will be required. To meet the needs for more complete treatment on site, education and training must be upgraded to an extent comparable to that required for registered nurses.

GERIATRIC SOCIAL WORKER

1,000,000 jobs. Starting salary, $15,000; average salary, $22,000.

These workers will be essential for the mental and social care of the nation's aging population. By the year 2000, the birthrate of native-born Americans will merely equal the "replacement rate"-zero population growth. Improvements in food, medicine, and life-extending medical processes will create the need for hundreds of thousands of workers to serve the aged.

Education and experience requirements comparable to those for licensed practical nurses, recreational specialists, mental hygienists, and dieticians will enable GSWs to find financially and physically rewarding employment.

Marvin Cetron and Thomas O'Toole

MODULE 3
APPRENTICESHIP IN THE 80's

EXERCISE MATERIALS

Exercise: High Technology and Apprenticeship Programs

1. Read the materials on "The Future and Jobs as the Experts See It" and NASA apprenticeship programs.

2. Describe experiences you have had that relate to the impact of new technologies on apprenticeship programs.

3. Develop a list of the key strategies and steps ATRs should use to help employers use and adjust to new technologies through apprenticeships.

4. Prepare a five minute summary of your discussion and select a spokesperson to present it to the class.

The Future and Jobs as the Experts See It

"The Robots Are Coming, The Robots Are Coming," shouts the title of an article by Fred Reed appearing recently in Next, a slick new magazine devoted to previewing the future. Robots are so new that no one is exactly sure how to define them. What is the distinction between special purpose automatic machinery and robots? Is an automatic washing machine a robot? The answer is no. The answer may be that to be called a robot, "the thing" must be capable of being programmed to do different jobs. In the automotive and aircraft industries, before a new model is put on the line, the factory is retooled. Retooling is expensive. It involves modifying existing machines, or building all new ones. A robot has an advantage over a riveting machine, for example, because the robot can be reprogrammed to put rivets into new places according to the new design.

It's going to be five or ten years before robots are carrying much of the load in assembly plants, says James S. Albut, roboticist-philosopher at the National Bureau of Standards. But the PUMA is already going to work in some factories. It is already changing the kind and amounts of work humans do. PUMA is an acronym for Programmable Universal Machine for Assembly. It is a little robot weighing about 120 pounds. The robots are definitely coming, and some of them are already here.

Robotics and home computers are two of the newest fields you will hear more about. The people already at work in them are pretty excited about the future. In their work, they get a clearer look at what will soon be commonplace. Our society is already being significantly shaped, economically, psychologically, and socially by the impact of increasing technology particularly in electronics, computers, and communication.

What will the future be like? What can we look forward to when many newly emerging careers are fully developed? For some answers we turned to the "futurists." They are a new emerging group of professionals who make their living by forecasting what the future will be like. Futurists, in general, tend to be excited by, and optimistic about, the new world that is emerging. Some of the more philosophic express a concern for the survival of our society. They stress that the future is not pre-determined. It is ours to create, and we need to be aware of this so we can move in the right direction to shape our future.

POPULATION

Population will continue to grow, but less rapidly. In 1982 the U.S. population was 230 million. By the year 2030 projections call for 300.3 million people in the United States. There will be more older persons among us. The percentage of Blacks, Asians and Hispanics will continue to grow. This changing mix in our population will force manufacturers and politicians to pay attention to the needs of older citizens and minorities to a larger extent than at present.

The 1980 census shows shifts in the location of the population. There was migration out of the heavily populated, industrialized Northeast and Middle Atlantic States and from areas around large cities such as Chicago, Detroit and Pittsburgh. Population is moving to the Southwestern states and to Florida. There is also a trend from large cities to smaller cities and towns. Because of advances in communications technology, it no longer is necessary for large corporations to locate all their key personnel in one city. More people are discovering the advantages of small town life--avoiding traffic jams, high living costs, air pollution, and crime. More people are also working out of their homes. This may be one of the most significant trends of the future.

HEALTH

People will be living longer. On July 1981 there were 36,589,000 people 60 and older. This figure will grow to 70.3 million by the year 2030. Medical science will also make longer lives more active and pleasant. The numbers and types of health care specialists at all levels have increased as medical science has advanced. All kinds of new "spare parts" banks, including more than 70 eye banks, already exist. Many scientist predict the use of electronically operated, artificial hearts. One prominent biologist believes that future generations do not need to die: people, who can afford it, will have their bodies frozen and reawakened when the disease or age to which they succumbed, has been conquered. Cryogenic technicians already exist in a number of communities.

COMPUTERIZED HOMES

Home computers are just now beginning to appear on the market in quantity and variety. They will bring the whole world, and a large percentage of its knowledge, to any user's living room. New learning networks will make learning much more available, while recreational networks will usher in an endless range of entertainment. Shopping and banking may be easily accomplished without leaving the house. The house will be managed by numerous new sensors which automatically control the heat, humidity, turn on the oven, etc. once they are programmed to do so. The number of choices available to the average person may become almost overwhelming.

Many more people will work at home. They will hold business conferences through closed circuit television and send reports and messages from home-based computer terminals.

There will be more devices to help the handicapped including the blind to communicate, move around, and in general participate more fully in daily life.

TOMORROW'S JOBS

To learn what is already happening to the world of work, one need only read the New York Times annual Career and National Recruitment Supplement. A recent annual issue not only contained many perceptive articles, but included more than 100 advertisements. Well over half of these were placed by companies in computers, computer software, computer services, communications, aerospace, and research development.

One ad headlined "In the Tomorrow-Minded World of Martin Marietta Aerospace, America's Future is the Agenda Today." Martin Marietta went on to list two dozen areas where it was seeking people for "entry-level growth positions"--including Software, Propulsion, Stuctures, Dynamics Stress, Mission Analysis Test, Thermodynamics, Mechanisms, Quality, Materials, Product Development, Industrial Engineering, Integration Systems, RF Systems, Data Handling, Payloads and Sensors, Logistics, Safety, Guidance and Control, Communications, Power Systems, and Manufacturing.

General Electric, "the company that's applying computer technology on a superscale," advertised openings at various experience levels in "Hardware: Computer Designers, Electronic Designers, Project Engineers/Managers, Materials Flow Specialists, Digital Systems Engineers, Installation, Service, Program Planning, Product Engineering, Mechanical Engineers (Applications Development)." In "Software" it had openings for "Systems Analysts, Data Base Designers, Software Engineers, CAD/CAM Designers, and Education/Training Specialists."

RCA Astro-Electronics, known for its historic trademark of a quisical dog looking into the speaker of a Victrola, needed ten different kinds of specific systems engineers, five kinds of mechanical engineers, six kinds of specialized engineers.

A number of chemical companies and drug companies courted the services of the highly trained. For example: "surface chemists, polymer chemists, analytical chemists." Just becoming a simple chemist or an engineer is no longer enough to land the really good jobs in the eighties.

A developer of synthetic fuels needed a "Coal Liquifaction Scientist," a "Reactor Systems Technology Engineer," a Computer Scientist, and a "Process Engineer--Waste Water Systems."

Several high-powered research and development organizations associated with universities, the Federal Government or private industry, advertised. The Plasma Physics Laboratory of Princeton University described in some detail eight different types of openings. It would seem to most readers that you have to be something of a specialist just to even understand the descriptions.

TRAVEL AND TRANSPORTATION

Travel and transportation will continue to develop. As one futurist said, "The American love affair with the automobile is here to stay until infinity because of the convenience and privacy it alone offers." This points to more small, fuel efficient cars, more electric cars, and more diesel-driven vehicles. More people will rely on public transportation for longer trips, usually travel by air. Crowed airport check-in counters and parking lots will not diminish the traveler's ardor as wide-bodied planes accommodate more and more passengers in a single flight. International travel to new exotic places will become possible for many more average American people through group tours and package plans.

Futurists see some improvement in luxury, inter-city bus service, particularly along the Northeast Corridor from Boston to Washington. Passenger train service will probably continue to decline. Urban transportation systems will grow only on the basis of available tax revenues rather than needs.

LEISURE

The average American of the future will probably work fewer hours per week. He or she may spend as much time or more in bureaucratic hassles, or being tied up in traffic jams. Nevertheless, a boom in the recreation industry is predicted. All sorts of delightful new theme parks will be available. The rage for family camping will continue although travel will become increasingly expensive. Many camping families will be forced to seek sites close to home. The National Parks will become more crowded, to the point of requiring far in advance reservations just to be admitted.

INFORMATION

According to Peter Schwartz the new era which is just now dawning will be based upon information. Dr. Schwartz is the widely respected young head of Future Studies at SRI International. He thinks the new era which is just dawning will be based on information. Information in its many forms will constitute our basic value--just as manufactured products was at the root of our value systems during the industrial era, and agricultural products in the agricultural age. The storing and transfer of information is already a sophisticated science. Sales of highly specialized information from every kind of consultant, including the futurists themselves, will become the major product of the future. Schwartz considers all kinds of services as consisting essentially of the sale of specialized information including everything from medical services, to television repair, to the local dry cleaner. The numbers and kinds of jobs in services are expanding more rapidly than in any other area.

One of the authors whose job was providing public relations service was trying to explain what she did to a friend from Turkey. During most of the explanation he wore a puzzled frown. Then he broke into a smile--"Oh, I see--what you sell then is nothing!" Like most merchants his concept of something you sell was limited to items manufactured or grown, something solid that had form and substance. Yet it is estimated that more than 80% of the workers of the future will be employed in the information sector.

SPACE TRAVEL

For many of us, space travel sounds like science fiction. Yet the Space Shuttle Columbia has already made four flights and has now become operational. A space laboratory has already been operated successfully. Space mechanics are being trained today. Futurists predict that by the year 2000 there will be regularly scheduled space travel for passengers and freight to and from space colonies. Thousands of Earthlings may work at beaming solar power back to earth.

For further elaboration see Emerging Careers's: New Occupations For The Year 2000 And Beyond by S. Norman Feingold and Norma R. Miller. Also see "Careers with a Future", in Careers Tomorrow, published by World Future Society, 1983.

NATIONAL APPRENTICESHIP AND TRAINING STANDARDS

NASA

GODDARD SPACE FLIGHT CENTER, NASA
GREENBELT, MARYLAND

SUPERVISION

The supervision of the Technician Apprenticeship Program is the responsibility of the Chief, Engineering Services Division, with line supervision of the apprentices delegated to the branch heads of the assigned work area. Each apprentice is assigned to a journeyman for day-to-day supervision.

EMPLOYMENT OF APPRENTICES

The Goddard Space Flight Center shall maintain a sufficient quantity of apprentice technicians to supply a reasonable number of journeymen technicians for scheduled expansion or normal turnover in the technical field.

SELECTION OF TECHNICIAN APPRENTICES

Apprentices may be selected from a variety of sources such as the Office of Personnel Management Register, special authorities such as the Veterans Readjustment Appointment, or by transfer, reinstatement, reassignment, or promotion through the Agency's merit promotion procedures. It is preferred that the apprentice is a graduate of a Trade School or High School.

PROBATIONARY PERIODS

Determinations regarding applicability of probationary periods for applicants selected for the Apprenticeship Program will be in accordance with Federal Personnel Manual Chapter 315.

REASSIGNMENT, SEPARATION, OTHER

Apprentices who at any time fail to meet the standards for shop and/or formal instructions of the TAP will be placed on a shop and/or academic probationary status for a 90-day period. This period may be extended up to an additional 90 days at the option of the Advisory Committee.

BEST COPY AVAILABLE

If, at the end of this period or at any time during this period, after the Apprentice is given full opportunity to meet the standards, it is determined that the shop or academic achievement of the Apprentice does not warrant continued participation in the program, the Apprentice may be removed from the TAP.

The Apprentice may also be removed from the TAP and be reassigned to another position, be disciplined, demoted or separated from the Federal Service at any time for such reasons as will promote the efficiency of the service.

CREDIT FOR PREVIOUS EDUCATION

Credit will be allowed for prior on-the-job training and/or classroom instruction, when the apprentice produces satisfactory evidence of equivalent experience and/or training in the specific courses of related instruction and placed in the grade to which advanced.

TRADES COVERED IN STANDARDS

The Goddard Space Flight Center's Technician Apprenticeship Program includes the following skills:

OPM TITLES	DOT#	DOL TITLES
1. Aerospace Engineering Tech. (Mach.)	007.161-026	Mechanical-Engineering Technician
2. Aerospace Engineering Tech. (Fab.)	007.161-026	Mechanical-Engineering Technician
3. Physical Science Tech. (Optics)	007.161-030	Optomechanical Technician
4. Aerospace Engineering Tech. (Plastics)	754.381-018	Plastics Bench Mechanic
5. Aerospace Engineering Tech. (Plating)	500.380-010	Plater
6. Aerospace Eng. Tech. (Metal Bonding)	011.261-014	Welding Technician
7. Electronics Technician	003.161-014	Electronics Technician

LENGTH OF APPRENTICESHIP PROGRAM

a. The TAP will be approximately 4 years. The program includes 2,080 hours per year which consists of on-the-job training, approved leave, and a minimum of 145 hours of formal classroom instruction. Classroom instruction is conducted by a Qualified Instructor at the Goddard Space Flight Center or local schools. Time spent in formal classroom instruction shall be considered as on-duty; however, time required to prepare for classroom instructions shall be on the apprentice's own time.

b. Technician Apprentices are subject to the same working hours and conditions as other Civil Service employees of the Goddard Space Flight Center.

EVALUATION

The performance of each apprentice in the shop and related instruction classes shall be evaluated at the end of each 3-month period during the first year of their training and at the end of each 6-month period during the remainder of their training program.

AEROSPACE ENGINEERING TECHNICIAN APPRENTICE (METAL BONDING)

The requirements of the Aerospace Engineering Technician Apprentice (Metal Bonding) will be considered fulfilled when the Apprentice has satisfactorily completed 8,320 hours of specified training and related study. A minimum of 832 hours will be devoted to classroom study.

Upon completion of this training, the Apprentice shall be capable of performing the following duties and shall possess the following skills and abilities:

Description of Duties:

1. Construction and assembly of aerospace research parts and equipment employing operations such as welding, bending, cutting, heat treating, drilling of metallic materials.

2. Bond aerospace research parts using metallic materials such as aluminum, stainless steel, titanium, magnesium, and unique aerospace alloys.

3. Operates arc welders, inert gas welders, spot welders, sanders, grinders, drilling machines, saws, power hand tools, and special welding fabrication tools such as laser welding equipment.

4. Reviews furnished drawings, sketches, and plans for missing details, incorrect measurements, and dimensions and assures compatibility of materials, fits, proper spatial relationship, and similar factors before work is started to further assure that end product will meet desired quality, accuracy, and performance. Where no drawings are furnished, and prototype item may eventually become a production item, either for in-house or contract manufacture, develops complete and detailed drawings.

5. Conducts trial-and-error experimentation with exotic and novel materials, subjects materials to various treatments and processes, develops modified techniques or approaches and tests for feasibility and adaptability of new materials, processes, and techniques to the work at hand.

6. Maintains, repairs, and adjusts laboratory and shop equipment.

Knowledge and Skills Required:

1. Ability to analyze assembly drawings of a project, determine the overall purpose, and visualize each component or part of the project from the standpoint of the fundamental design characteristics.

2. Ability to lay out work from blueprints, sketches, and verbal assignments, and to plan operational sequence to be used in bonding each part, demonstrating sound knowledge of all available workholding devices and other methods of securing and supporting the work during actual cutting and welding operations.

3. Ability to evaluate each part to plan procedure by which related techniques, such as heat-treating operations, silver-soldering, brazing, and welding, as required, will fit into the operation in proper sequence.

4. Ability to select tools and machine to perform operations to produce parts to specification and perform all welding and assembly operations to complete the project.

5. Ability to use and understand functions and use of gauges and measuring devices, such as micrometers, vernier systems, optical measuring, and comparative equipment commonly used in shops.

6. Ability to select correct material, i.e., type, strength, temper, gauge, etc., and ability to protect material properties, so that the final assemblies will be able to withstand stresses, strains, friction, vacuum effects, and other conditions encountered in aeronautical and aerospace research and development.

7. Must have high initial accuracy. Since the end product in research is an experimental item and experimentation is always changing, requirements for initial accuracy are very high, repetitive assignments are rare, and requirements for machine adaptation and process development occur frequently.

8. Must have successfully completed the requirements of MIL-STD 1595 for Aerospace Welder Performance Qualification for Aluminum Alloys, Ferrous Alloys, and Titanium Alloys, and must be capable of producing Type I, Grade A quality brazed joints in steels, copper alloys, and nickel alloys in accordance with the requirements of Military Specification Mil-B-7883B.

AEROSPACE ENGINEERING TECHNICIAN APPRENTICE (METAL BONDING)

TRAINING SCHEDULE

Shop Training	Hours
Industrial Safety	40
Operation and setup of standard fabrication/welding tools and instruments	1000
Fabrication of aerospace experimental models	2200
Fabrication, assembly, installation, modification and repair of laboratory and flight components for spacecraft	2200
Fabrication and assembly of ground support equipment	1050
Precision measurement and layout	1000
COURSE TOTAL	7490

NOTE: Hours as listed are approximate and may vary to meet the needs of the program.

ACADEMIC REQUIREMENTS

Course	Hours
Basic Electricity I	26
Blueprint Reading/Mech. Dr. I	52
Communication Skills	26
Hand Tools	26
Math Review	26
Technical Math I	52
Blueprint Reading/Mech. Dr. II	52
Individual Instruction	26
Shop Technology I	52
Technical Math II	52
Vacuum Systems	26
Automatically Programmed Tool Part Programming	78
Blueprint Reading/Mech. Dr. III	52
Shop Technology II	26
Technical Math III	52
Applied Physics	52
Geometrical Tolerancing	52
Heat Treat, Welding & Properties	52
Individual Instruction	26
Sheet Metal Technology	26
	832 TOTAL

AEROSPACE ENGINEERING TECHNICIAN APPRENTICE (MACHINING)

The requirements of the Aerospace Engineering Apprentice (Machining) will be considered fulfilled when the Apprentice has satisfactorily completed 8,320 hours of specified training and related study. A minimum of 832 hours will be devoted to related classroom study.

Upon completion of this Apprenticeship Program, the employee shall be capable of performing the following duties and shall possess the following skills and abilities:

Description of Duties:

1. Receives work assignments from supervisor or researcher with specific instructions on objectives and desired results. Plans and develops own layout and approach to work assignments. Reviews plans and layout with supervisor to insure proper sequence, etc. Arranges for procurement of materials and support services as required.

2. Constructs aerospace research parts and equipment using both ferrous and nonferrous metals including high-temperature-resisting alloys, as well as such plastics as nylon, teflon and plexiglass.

3. Operates lathe, milling machine, horizontal and vertical boring mills, and other general toolroom machines with duplicating attachments, index heads, rotary heads, numerically controlled machines, and other special tool attachments.

4. Reviews furnished drawings, sketches, and plans for missing details, incorrect measurements, and dimensions and assures for compatability of materials, fits, proper spatial relationship, and similar factors before work is started to further assure that end product will meet desired quality, accuracy, and performance. Where no drawings are furnished, and prototype item may eventually become a production item, either for in-house or contract manufacture, develops complete and detailed drawings.

5. Conducts a trial-and-error experimentation with exotic and novel materials, subjects materials to various treatments and processes, develops modified techniques or approaches and tests for feasibility and adaptability of new materials, processes, and techniques to the work at hand.

Knowledge and Skills Required:

1. Ability to analyze assembly drawings of a project, determine its overall purpose, and visualize each component or part of the project from the standpoint of its fundamental design characteristics.

2. Ability to layout work from blueprints, sketches, and verbal assignments, and to plan operational sequence to be used in machining each part, demonstrating sound knowledge of all available workholding devices and other methods of securing and supporting the work during actual cutting on lathe, drilling and milling machines, boring mills, etc.

AEROSPACE ENGINEERING TECHNICIAN APPRENTICE (FABRICATION)

The requirements of the Aerospace Engineering Technician Apprentice (Fabrication) will be considered fulfilled when the Apprentice has satisfactorily completed 8,320 hours of specified training and related study. A minimum of 832 hours will be devoted to related classroom study.

Upon completion of this Apprentice Program, the Apprentice shall be capable of performing the following duties and shall possess the following skills and abilities:

Description of Duties:

1. Constructs and assembles aerospace research parts and equipment employing operations such as bending, cutting, punching, drilling, grinding, finishing, and operating power shop machinery.
2. Must be able to install or use solid and blind-type fasteners, pneumatic squeezers, hammers, huck and cherry rivet tools, and dies for pressure forming metals.
3. Performs experiments that require a knowledge of the characteristics and properties of materials, metals, alloys, superalloys, composites, etc., and applies this working knowledge to develop and fabricate the finished product that meets space-age hardware, model, and flight vehicle requirements. The awarenes of the compatibility or incompatibility of metals and materials both to themselves and their environment is a necessity.
4. Collaborates with supervisors, engineers, and scientific personnel with regards to the design problems. Participates in predesign discussions, feasible design approach, fabrication techniques, tooling requirements, methods of performing the work and many other problems of completing a project.
5. Frequently is required to produce detailed sketches, and does the simple engineering calculations necessary. Does the required liaison to coordinate own efforts and those of others to accomplish assigned project. Keeps records and makes notes on work performed, observations made, data taken and makes initial summaries.
6. Studies designated material brochures, manuals, fact sheets, etc., relative to new materials and fabrication techniques adaptable to current and future needs and applies such knowledge to work assignments. Utilizes the standard as well as the new and sophisticated methods of joining materials, e.g., diffusion bonding, electron beam, laser, and solid state welding.

Knowledge and Skills Required:

1. Ability to work from drawings, sketches, or verbal instructions.
2. Ability to calculate bend allowance on metals to be worked upon, and layout brake marks accordingly; to select proper dies to use and set them up in presses in the required positions, when braking metal up to correct angle needed; to observe if press is operating in safe, normal and proper manner.

PHYSICAL SCIENCE TECHNICIAN APPRENTICE (OPTICS)

The requirements of the Physical Science Technician Apprentice (Optics) will be considered fulfilled when the Apprentice has satisfactorily completed 8,320 hours of specified training and related study. A minimum of 832 hours will be devoted to classroom study.

Upon completion of this training, the Apprentice shall be capable of performing the following duties and shall possess the following skills and abilities:

Description of Duties:

1. Performs standard laboratory operations such as: blocking, etching, cutting, grinding and polishing of glass; vaporization and controlled deposition of metallic and dielectric materials in vacuum chambers by the use of resistance heating techniques.

2. Constructs aerospace research parts using dielectric, conductor and semiconductor materials.

3. Operates standard laboratory measurement instrumentation such as: interference microscopes, Tyman Green interferometer, Michelson interferometer, phase contrast microscope, polarimeter, spherometer, vernier caliper, micrometers, PH meter, electronic thermometer, high voltage power supplies, oscillating crystal deposition monitors, optical deposition monitors and spectrophometer, autocollimators.

4. Operates machines to fabricate and finish pieces of two- or three-dimensional configuration to:

   Absolute dimensional accuracies to:

   - Surface regularity of 50 nanometers
   - Surface finish of 2 nanometers rms

5. Operates vacuum chamber evacuation and deposition monitor equipment annealing ovens, glass blowing lathes, optical polishing machines, machines used for internal, edge and surface grinding, sawing and drilling of optical materials, curve generators and other general tool room machines with duplicating attachments, index heads, rotary heads and other special tool attachments.

6. Maintains, repairs, and adjusts laboratory equipment.

7. Maintains a laboratory notebook of task assignments including task description, materials, and fabrication technique used, measurements performed on finished part. Maintains a daily log of hourly on-the-job skill training.

8. Assembles and aligns optical components to be used in engineering, prototype or flight systems.

AEROSPACE ENGINEERING TECHNICIAN APPRENTICE (PLASTICS)

The requirements of the Aerospace Engineering Technician Apprentice (Plastics) will be considered fulfilled when the Apprentice has satisfactorily completed 8,320 hours of specified training and related study. A minimum of 832 hours will be devoted to classroom study.

Upon completion of this training, the Apprentice shall be capable of performing the following duties and shall possess the following skills and abilities:

Description of Duties:

1. Constructs and assembles aerospace research parts and equipment employing operations, such as bending, cutting, turning, and drilling of nonmetallic materials.
2. Constructs aerospace research parts using plastics materials such as plexiglas, fiberglas, and unique aerospace compounds.
3. Operates lathes, milling machines, saws, jointers, power hand tools, and special plastic fabrication tools.
4. Reviews furnished drawings, sketches, and plans for missing details, incorrect measurements, and dimensions and assures compatibility of materials, fits, proper spatial relationship, and similar factors before work is started to further assure that end product will meet desired quality, accuracy, and performance. Where no drawings are furnished, and prototype item may eventually become a production item, either for in-house or contract manufacture, develops complete and detailed drawings.
5. Conducts trial-and-error experimentation with exotic and novel materials, subjects materials to various treatments and processess, develops modified techniques or approaches and tests for feasibility and adaptability of new materials, processes, and techniques to the work at hand.
6. Maintains, repairs, and adjusts laboratory equipment.

Knowledge and Skills Required:

1. Ability to analyze assembly drawings of a project, determine the overall purpose, and visualize each component or part of the project from the standpoint of the fundamental design characteristics.
2. Ability to lay out work from blueprints, sketches, and verbal assignments, and to plan operational sequence to be used in machining each part, demonstrating sound knowledge of all available workholding devices and other methods of securing and supporting the work during actual cutting on lathe, drilling and milling machines, saws, jointers, etc.
3. Ability to evaluate each part to plan procedure by which related techniques, such as heat-treating operations, silver-soldering, brazing and welding, as required, will fit into the operation in proper sequence.

AEROSPACE ENGINEERING TECHNICIAN APPRENTICE (PLATING)

The requirements of the Aerospace Engineering Technician Apprentice (plating) will be considered fulfilled when the Apprentice has satisfactorily completed 8,320 hours of specified training and related study. A minimum of 832 hours will be devoted to classroom study.

Upon completion of this training, the Apprentice shall be capable of performing the following duties and shall possess the following skills and abilities:

Description of Duties:

1. Receives work assignments from supervisor or researcher with specific instructions on objectives and desired results. Plans and develops own approach to work assignments. Reviews plans with supervisor to insure proper sequence, etc. Arranges for procurement of materials and support services as required.

2. Operates standard laboratory measurement instrumentation such as: microscopes, micrometers. PH meter. electronic thermometer. high voltage power supplies, industrial cameras and photo etch equipment.

3. Setup and maintain standard electrochemical baths as well as unique experimental solutions for aerospace applications.

4. Records pertinent data on status of plating baths, chemical analysis, time and temperature.

5. Investigates and develops procedures to apply such metals as copper, nickel, chromium, gold, tin and tin nickel to a variety of materials (aluminum, brass, copper, magnesium, steel, titanium, etc., as well as nonmetallics), by chemical or electrochemical methods.

6. Uses industrial photochemical techniques and equipment for photo-etching metallic aerospace materials.

7. Maintains a laboratory notebook of task assignments including task description, materials, photochemical/electrochemical technique used as well as measurements.

Knowledge and Skills Required:

1. Ability to analyze drawing of a project, determine the use and overall purpose and select the appropriate electrochemical process which will meet the specifications.

2. Ability to evaluate each phase of the planned procedure by which related techniques, such as chemical cleaning, plating, photo-etching, buffing, etc., fit into the operation in the proper sequence.

3. Ability to select tools, racks, materials, and electrochemical equipment to perform operations to produce components and coating to specifications and to perform all electrochemical/photochemical operations to complete the project.

MODULE 3
APPRENTICESHIP IN THE 80'S

ATR GUIDEBOOK

New Occupations Forecast

Occupation	Salary Range		Number of Jobs
	Start	Average	
Energy Technician	$13,000	$26,000	1,500,000
Housing Rehabilitation Technician	14,000	24,000	1,750,000
Hazardous Waste Management Technician	15,000	28,000	1,500,000
Industrial Laser Process Technician	15,000	25,000	2,500,000
Robot Technicians	15,000	24,000	1,500,000
Materials Utilization Technicians	15,000	24,000	500,000
Genetic Engineering Technician	20,000	30,000	150,000
Holographic Inspection Specialist	20,000	28,000	200,000
Bionic-Electronic Technician	21,000	32,000	200,000
Battery Technician	12,000	18,000	250,000
Paramedic	16,000	29,000	1,300,000
Geriatric Social Worker	15,000	20,000	1,000,000

Future Employment Projections

Occupations Producing the Most New Jobs

	1980 Employment	Projected growth, 1980-90	Percent growth
Secretaries	2,469,000	700,000	28.3%
Nurses' Aides, orderlies	1,175,000	508,000	43.2
Janitors, sextons	2,751,000	479,000	18.2
Sales clerks	2,880,000	479,000	16.7
Cashiers	1,597,000	452,000	28.4
Professional nurses	1,104,000	437,000	39.6
Truck drivers	1,696,000	415,000	24.5
Fast-food workers	806,000	400,000	49.6
General office clerks	2,395,000	377,000	15.8
Waiters, waitresses	1,711,000	360,000	21.1
Elementary teachers	1,286,000	251,000	19.5
Kitchen helpers	839,000	231,000	27.6
Accountants, auditors	833,000	221,000	26.5
Construction helpers	955,000	212,000	22.2
Automotive mechanics	846,000	206,000	24.4
Blue-collar supervisors	1,297,000	206,000	15.9
Typists	1,067,000	187,000	17.5
Licensed practical nurses	522,000	185,000	35.5
Carpenters	970,000	173,000	17.9
Bookeepers	975.000	167,000	17.2

Five Fastest Growing High Technology Jobs

	1980 Employment	Project growth, 1980-90	Percent growth
Data processing mechanics	83,000	77,000	92.3%
Computer operators	185,000	133,000	71.6
Computer analysts	205,000	139,000	67.8
Office machine servicers	55,000	33,000	59.8
Computer programmers	228,000	112,000	48.8

Source: Bureau of Labor Statistics

Occupations Accounting For 50 Percent Of All New Jobs During The 1980's

OCCUPATION	GROWTH IN EMPLOYMENT 1980-1990 (IN THOUSANDS)
SECRETARIES ...L	700
NURSES'AIDES AND ORDERLIES ..L	508
JANITORS AND SEXTONS..L	501
SALES CLERKS..L	479
CASHIERS....L	452
NURSES PROFESSIONAL	437
TRUCK DRIVERS..L	415
FOOD SERVICE WORKERS, FAST FOOD RESTAURANTS..L	400
GENERAL CLERKS, OFFICE.L	377
WAITERS AND WAITRESSES..L	360
ELEMENTARY SCHOOL TEACHERS..L	251
KITCHEN HELPERS..L	231
ACCOUNTANTS AND AUDITORS	221
HELPERS, TRADES...L	212
AUTOMOTIVE MECHANICS	206
BLUE-COLLAR WORKER SUPERVISORS	206
TYPISTS	187
LICENSED PRACTICAL NURSES	185
CARPENTERS	173
BOOKKEEPERS, HAND	167
GUARDS AND DOORKEEPERS.L	153
STOCK CLERKS, STOCKROOM AND WAREHOUSE	142
COMPUTER SYSTEMS ANALYSTS	139
STORE MANAGERS	139
PHYSICIANS, MEDICAL AND OSTEOPATHIC	135
MAINTENANCE REPAIRERS, GENERAL UTILITY	134
COMPUTER OPERATORS	132
CHILD CARE WORKERS, EXCEPT PRIVATE HOUSEHOLD	125
WELDERS AND FLAMECUTTERS	123
STOCK CLERKS, SALES FLOOR	120
ELECTRICAL ENGINEERS	115
COMPUTER PROGRAMMERS	112
ELECTRICIANS	109
BANK TELLERS	108
ELECTRICAL AND ELECTRONIC TECHNICIANS	107
LAWYERS	107
SALES AGENTS AND REPRESENTATIVES, REAL ESTATE	102

SOURCE: BUREAU OF LABOR STATISTICS

Fastest Growing Occupations Requiring Postsecondary Education And Training (But Less Than A Bachelor's Degree)

OCCUPATION	PERCENT CHANGE IN EMPLOYMENT, 1980-1990	EMPLOYMENT, 1980 (IN THOUSANDS)
PARALEGAL PERSONNEL	109-139	32
DATA PROCESSING MACHINE MECHANICS	93-112	83
COMPUTER OPERATORS	72-83	185
OFFICE MACHINE AND CASH REGISTER SERVICERS	60-73	55
TAX PREPARERS	49-70	31
EMPLOYMENT INTERVIEWERS	47-64	58
PERIPHERAL EDP EQUIPMENT OPERATORS	44-52	49
TRAVEL AGENTS AND ACCOMODATIONS APPRAISERS	43-52	52
CLAIMS AGENTS	43-46	40
BRICKMASONS	40-51	146
NURSES, PROFESSIONAL	40-47	1,104
SURGICAL TECHNICIANS	39-45	32
DENTAL HYGIENISTS	39-42	61
HEALTH RECORDS TECHNOLOGISTS	38-44	32
CONCRETE AND TERRAZZO FINISHERS	37-47	113

SOURCE: BUREAU OF LABOR STATISTICS

Occupations Declining During The 1980's

OCCUPATION	PERCENT CHANGE IN EMPLOYMENT, 1980-1990	EMPLOYMENT, 1980 (IN THOUSANDS)
FARM LABORERS	-20	1,175
GRADUATE ASSISTANTS	-18	132
FARMERS	-17	1,447
SHOEMAKING MACHINE OPERATORS	-17	65
SECONDARY SCHOOL TEACHERS	-14	1,237
COLLEGE AND UNIVERSITY TEACHERS	-12	457
COMPOSITORS AND TYPESETTERS	-10	128
MAIDS AND SERVANTS, PRIVATE HOUSEHOLD	-6	478
CENTRAL OFFICE REPAIRERS	-6	51
TICKET AGENTS	-4	53
TAXI DRIVERS	-3	71
CLERGY	-3	296
POSTAL CLERKS	-2	316

SOURCE: BUREAU OF LABOR STATISTICS

Detailed Occupational Projections

Bureau of Labor and Statistics

This appendix presents estimates of 1980 employment and projections of 1990 employment by detailed occupation. It provides 1980 estimates of employment, three alternative 1990 projections and the 1980-90 percent change for 670 detailed occupations. This table includes only occupations with 1980 employment of 5,000 or higher.

Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Total, all occupations	102,107.3	119,591.1	127,908.4	121,448.5	17.1	25.3	18.9
Professional, technical, and related workers	16,395.2	19,662.3	20,727.6	19,917.4	19.9	26.4	21.5
Engineers[1]	1,177.8	1,504.3	1,624.3	1,531.2	27.7	37.9	30.0
Aeronautical and astronautical engineers	68.0	97.6	103.6	100.1	43.4	52.3	47.2
Chemical engineers	55.5	68.4	73.1	70.0	23.2	31.6	26.0
Civil engineers	165.4	207.9	217.2	210.3	25.7	31.3	27.1
Electrical engineers	326.7	441.2	479.9	449.2	35.1	46.9	37.5
Industrial engineers	115.9	145.7	159.3	148.3	25.8	37.5	28.0
Mechanical engineers	212.9	273.9	300.0	279.1	28.7	40.9	31.1
Metallurgical engineers	15.4	20.4	22.0	20.8	32.4	42.5	34.7
Mining engineers	6.1	8.4	9.2	8.7	37.7	51.2	42.6
Petroleum engineers	17.9	26.0	27.6	25.8	45.7	54.2	44.3
All other engineers	193.9	214.6	232.5	218.9	10.7	19.9	12.9
Life and physical scientists	253.8	300.2	317.3	305.6	18.2	25.0	20.4
Agricultural scientists	19.8	21.6	22.7	22.1	9.1	14.3	11.5
Biological scientists	44.8	51.2	54.1	52.5	14.1	20.7	17.0
Chemists	93.6	112.9	119.5	115.0	20.6	27.6	22.8
Geologists	39.8	51.7	54.9	52.0	30.1	38.2	30.7
Medical scientists	8.1	9.4	9.7	9.4	15.6	19.4	15.8
Physicists	20.5	23.1	24.4	23.6	12.5	19.0	14.8
All other life and physical scientists	27.1	30.3	32.0	31.1	11.6	18.1	14.5
Mathematical specialists	52.0	61.7	65.8	63.3	18.7	26.5	21.6
Actuaries	7.8	10.9	11.6	11.3	39.5	48.3	44.8
Mathematicians	12.7	14.4	15.2	14.7	13.2	20.0	15.8
Statisticians	26.5	30.9	33.2	31.6	16.7	25.2	19.3
All other mathematical specialists	5.0	5.6	5.8	5.7	10.9	16.3	13.2
Engineering and science technicians[1]	1,267.9	1,578.0	1,700.8	1,610.1	24.5	34.1	27.0
Broadcast technicians	16.5	17.8	18.4	17.8	7.5	11.4	7.7
Civil engineering technicians	24.6	30.7	31.6	31.1	24.8	28.4	26.2
Drafters	321.6	411.1	445.3	418.8	27.9	38.5	30.2
Electrical and electronic technicians	359.5	466.3	513.8	480.3	29.7	42.9	33.6
Industrial engineering technicians	32.4	40.2	43.6	40.8	24.0	34.4	25.7
Mechanical engineering technicians	48.5	60.9	67.1	62.2	25.5	38.2	28.1
Surveyors	61.3	72.9	78.0	75.4	18.8	27.2	22.9
All other engineering and science technicians	403.4	478.0	503.0	483.8	18.5	24.7	19.9
Medical workers, except technicians	2,198.7	2,932.6	3,099.2	2,958.0	33.4	41.0	34.5
Chiropractors	23.0	27.0	29.5	27.8	17.2	28.1	20.7
Dentists[1]	170.7	208.3	222.7	212.4	22.0	30.4	24.4
Dietitians	44.2	60.9	64.5	62.4	37.6	45.8	41.0
Nurses, professional	1,104.0	1,541.5	1,617.4	1,550.9	39.6	46.5	40.5
Optometrists	27.1	32.7	35.5	33.1	21.0	31.3	22.4
Pharmacists	141.2	157.5	169.9	155.2	11.5	20.3	9.9
Physicians, medical and osteopathic[1]	491.1	625.6	664.6	631.2	27.4	35.3	28.5
Podiatrists	12.1	16.1	17.5	16.5	32.6	44.3	35.8
Therapists	149.6	216.5	226.8	218.9	44.7	51.6	46.4
Inhalation therapists	18.3	26.1	27.4	26.3	42.3	49.5	43.1
Manual arts, music, and recreational therapists	23.6	34.6	37.2	35.3	46.7	58.0	49.9
Occupational therapists	19.0	30.9	32.5	31.3	62.7	71.4	64.9
Physical therapists	34.2	51.6	54.5	52.3	50.9	59.4	53.0
Speech and hearing clinicians	35.2	51.6	52.8	51.8	46.6	50.2	47.4
All other therapists	19.3	21.8	22.3	21.9	12.6	15.2	13.4
Veterinarians	35.5	46.6	50.8	49.6	31.1	42.9	39.4
Health technologists and technicians	1,202.6	1,617.5	1,707.9	1,628.0	34.5	42.0	35.4
Cytotechnologists	5.3	7.0	7.7	7.0	32.5	46.9	34.2
Dental hygienists	60.6	84.4	86.2	83.5	39.2	42.3	37.8
Dietetic technicians	[illegible].8	9.1	10.0	9.4	56.6	72.8	62.2
EKG technicians	19.7	26.2	27.3	26.2	33.3	39.0	33.1
Health records technologists	31.6	43.6	45.5	43.6	37.8	43.9	38.0
Licensed practical nurses[1]	521.7	706.9	751.6	717.1	35.5	44.1	37.5
Medical technicians	88.2	119.1	126.7	119.4	35.0	43.6	35.3
Medical laboratory technologists	105.0	140.8	149.4	141.2	34.0	42.2	34.4
Pharmacy helpers	23.1	30.3	31.8	30.2	31.3	37.5	30.7
Physical therapy technicians	11.3	16.7	18.0	17.0	47.9	59.5	50.2
Radiologic and nuclear medicine technicians	14.0	18.2	19.1	18.2	29.9	36.7	30.3

See footnotes at end of table.

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Surgical technicians	31.5	43.9	45.8	43.9	39.3	45.4	39.2
X-ray technicians	92.3	126.4	132.6	126.2	36.8	43.6	36.6
All other health technologists and technicians	192.5	245.0	256.1	245.2	27.3	33.1	27.4
Technicians, except health, science, and engineering	289.4	330.2	349.0	333.8	14.1	20.6	15.3
Airplane pilots	81.7	94.2	100.5	95.6	15.3	23.0	17.0
Air traffic controllers	29.0	33.6	34.3	33.7	16.1	18.5	16.4
Embalmers	11.4	11.6	14.0	12.8	2.0	22.9	13.1
Flight engineers	5.9	6.4	6.8	6.4	8.0	14.7	8.8
Radio operators	5.9	6.8	7.1	6.7	15.2	20.5	14.8
Technical assistants, library	35.5	35.5	35.7	35.4	.1	6	-.2
Tool programmers, numerical control	11.9	13.8	15.3	14.1	15.8	28.4	17.9
All other technicians, except health, science, and engineering	108.2	128.4	135.4	129.0	18.6	25.1	19.2
Computer specialists	432.8	683.1	733.9	697.2	57.8	69.6	61.1
Computer programmers	228.2	339.9	366.0	346.6	48.9	60.4	51.8
Computer systems analysts	204.6	343.2	367.9	350.6	67.7	79.8	71.4
Social scientists	189.6	242.4	255.4	248.0	27.9	34.7	30.8
Economists	28.8	40.9	43.3	41.5	42.0	50.1	44.0
Financial analysts	14.3	18.5	20.2	19.5	29.7	41.7	37.0
Psychologists [1]	82.5	106.5	111.1	108.5	29.2	34.8	31.6
Sociologists	6.4	7.7	8.1	7.9	20.3	27.4	24.5
Urban and regional planners	23.1	29.4	30.3	29.7	27.5	31.3	28.7
All other social scientists	34.6	39.4	42.4	40.8	13.8	22.6	17.9
Teachers	3,915.5	4,048.1	4,081.6	4,042.6	3.4	4.2	3.2
Adult education teachers	107.4	123.1	125.9	123.4	14.6	17.2	14.8
College and university teachers	457.4	405.1	406.6	404.1	-11.4	-11.1	-11.6
Dance instructors	22.5	25.6	27.2	24.8	13.5	20.5	9.9
Elementary school teachers	1,285.6	1,536.6	1,542.3	1,532.9	19.5	20.0	19.2
Extension service specialists	6.0	5.8	5.8	5.8	-3.1	-2.8	-3.4
Graduate assistants	132.1	108.7	109.1	108.4	-17.7	-17.4	-17.9
Preschool and kindergarten teachers	474.6	570.3	575.5	568.5	20.2	21.3	19.8
Secondary school teachers	1,237.2	1,061.6	1,065.6	1,059.1	-14.2	-13.9	-14.4
Vocational education teachers	27.0	33.2	34.2	33.3	22.8	26.5	23.2
All other teachers	165.6	178.2	189.3	182.4	7.6	14.3	10.1
Selected writers, artists, and entertainers	969.3	1,115.4	1,196.4	1,132.8	15.1	23.4	16.9
Actors	20.8	24.6	26.2	24.7	18.5	25.9	18.7
Athletes	20.5	22.4	24.2	23.6	8.8	17.7	14.7
Commercial artists	120.1	121.9	133.6	126.2	1.5	11.2	5.1
Dancers	6.5	7.8	7.8	7.9	19.9	20.3	21.7
Designers	165.4	189.2	206.1	185.1	14.4	24.6	11.9
Musicians, instrumental	138.2	159.7	165.4	165.4	15.5	19.7	19.6
Painters, artistic	22.4	19.5	21.5	20.3	-12.6	-3.9	-9.3
Photographers	90.7	104.2	112.9	103.7	14.9	24.5	14.4
Public relations specialists	86.6	101.8	108.9	104.3	17.5	25.7	20.4
Radio and television announcers	51.0	65.5	68.1	65.7	28.4	33.5	28.7
Announcers	42.8	54.7	56.9	54.8	27.8	32.9	28.1
Broadcast news analysts	8.2	10.8	11.2	10.8	31.1	36.3	31.3
Reporters and correspondents	57.3	70.0	75.4	72.0	22.2	31.7	25.7
Singers	18.9	21.0	22.5	21.8	11.0	18.9	15.4
Sports instructors	36.4	41.1	43.4	41.3	13.2	19.3	13.5
Writers and editors	118.0	144.5	156.9	148.6	22.5	33.0	25.9
Writers, artists, and entertainers, n.e.c	8.1	9.4	9.9	9.4	16.8	22.5	16.6
Other professional and technical workers	4,445.7	5,248.7	5,595.9	5,366.9	18.1	25.9	20.7
Accountants and auditors [1]	833.2	1,053.9	1,131.4	1,078.7	26.5	35.8	29.5
Architects	79.5	105.5	112.1	108.4	32.7	41.0	36.3
Assessors	32.4	37.8	38.5	37.9	16.8	18.8	17.0
Audiovisual specialists, education	10.6	10.3	10.3	10.2	-3.4	-3.0	-3.6
Brokers, floor representatives, and security traders	7.8	9.4	10.8	10.4	21.3	38.7	33.5
Buyers, retail and wholesale trade [1]	251.9	296.3	319.6	298.1	17.6	26.9	18.3
Claim examiners, property/casualty insurance	22.0	32.5	33.5	32.8	47.3	52.1	48.6
Claims takers, unemployment benefits	15.2	17.8	18.2	17.9	17.4	19.8	17.8
Clergy	296.0	288.5	309.9	298.3	-2.5	4.7	8
Cost estimators	85.7	105.8	113.2	108.5	23.5	32.1	26.6
Credit analysts, chief	7.7	9.7	10.4	10.1	25.8	35.0	31.0

See footnotes at end of table

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Credit analysts	24.1	29.5	32.1	31.1	22.5	33.5	29.4
Directors, religious education and activities	35.8	36.6	39.4	37.9	2.2	9.9	5.8
Employment interviewers	58.2	85.6	95.3	88.3	47.0	63.7	51.8
Foresters	29.5	32.2	33.6	33.0	9.2	13.9	12.0
Insurance investigators	9.7	13.2	14.0	13.5	36.3	43.6	38.8
Judges	19.9	22.9	23.3	22.9	15.0	17.0	15.2
Law clerks	32.7	42.6	48.0	44.3	30.2	46.8	35.4
Lawyers	416.2	523.5	579.9	543.3	25.8	39.4	30.5
Librarians	134.3	138.5	141.1	139.0	3.1	5.1	3.5
Magistrates	10.1	11.8	12.0	11.8	16.7	18.7	16.9
Media buyers	15.1	17.5	19.4	18.3	16.3	28.5	21.6
Paralegal personnel	31.5	65.8	75.3	68.8	106.9	138.8	118.4
Personnel and labor relations specialists	178.2	205.1	217.2	208.2	15.1	21.9	16.8
Purchasing agents and buyers	172.3	199.5	213.8	202.4	15.8	24.1	17.5
Recreation workers, group	130.2	152.3	159.7	156.6	16.9	22.6	20.2
Safety inspectors	5.9	7.4	7.6	7.4	24.8	29.2	25.8
Social workers	344.8	413.8	427.6	422.7	20.0	24.0	22.6
Caseworkers	289.5	342.4	353.9	349.8	18.3	22.3	20.8
Community organization workers	55.3	71.4	73.7	72.9	29.2	33.3	31.9
Special agents, insurance	24.0	29.1	30.2	29.5	21.7	25.9	23.1
Tax examiners, collectors, and revenue agents	54.1	60.3	61.4	60.4	11.5	13.6	11.7
Tax preparers	31.1	46.2	52.8	50.0	48.6	69.8	60.8
Title examiners and abstractors	10.2	17.4	18.0	17.4	70.6	76.1	69.7
Underwriters	76.2	89.5	93.3	89.9	17.5	22.6	18.1
Vocational and educational counselors	207.6	210.5	213.9	211.8	1.4	3.0	2.0
Welfare investigators	11.7	13.6	13.9	13.7	16.0	18.1	16.4
All other professional workers	737.7	814.0	862.5	831.0	10.4	16.9	12.7
Managers, officials, and proprietors	9,355.4	10,562.5	11,344.1	10,760.5	12.9	21.3	15.0
Auto parts department managers	46.7	54.2	58.9	59.0	16.1	26.1	26.4
Auto service department managers	58.1	68.9	74.9	75.2	18.6	28.9	29.4
Construction inspectors, public administration	48.3	60.8	61.9	60.9	26.0	28.2	26.2
Inspectors, except construction, public administration	111.7	125.1	127.5	125.4	12.0	14.1	12.2
Postmasters and mail superintendents	28.3	28.9	30.0	29.1	2.1	5.9	2.9
Railroad conductors	33.2	31.2	34.3	31.5	-6.3	3.3	-5.2
Restaurant, cafe, and bar managers	556.9	642.0	680.0	650.1	15.3	22.1	16.7
Sales managers, retail trade	273.1	323.4	351.2	322.8	18.4	28.6	18.2
Store managers	961.9	1,101.3	1,182.8	1,106.6	14.5	23.0	15.0
Wholesalers	248.5	279.4	306.8	283.6	12.4	23.5	14.1
All other managers	6,988.6	7,847.3	8,435.8	8,016.1	12.3	20.7	14.7
Sales workers	6,821.5	8,112.2	8,763.2	8,204.5	18.9	28.5	20.3
Brokers and market operators, commodities	5.8	8.3	9.5	9.1	42.4	63.7	56.8
Contribution solicitors	6.7	9.0	9.5	9.4	34.4	41.1	40.0
Crating and moving estimators	7.5	10.1	10.5	9.8	33.7	39.7	29.9
Real estate appraisers	35.9	47.1	50.5	48.2	31.1	40.5	34.2
Real estate brokers	38.7	47.9	52.5	48.6	23.9	35.8	25.8
Sales agents and representatives, real estate	291.8	393.7	430.3	400.5	34.9	47.5	37.2
Sales agents and representatives, insurance	327.3	398.6	420.4	405.4	21.8	28.4	23.9
Sales agents and representatives, securities	63.4	80.0	91.6	88.2	26.2	44.4	39.1
Sales clerks	2,879.9	3,359.2	3,598.5	3,359.3	16.6	25.0	16.6
Travel agents and accommodations appraisers	52.1	74.7	79.4	74.9	43.4	52.4	43.8
Vendors	6.9	9.1	9.7	9.2	31.3	40.2	33.1
All other sales workers	3,105.5	3,674.5	4,000.9	3,741.9	18.3	28.8	20.5
Clerical workers	18,863.8	22,417.6	23,917.0	22,720.5	18.8	26.8	20.4
Adjustment clerks	37.3	45.4	47.6	45.7	21.7	27.5	22.4
Admissions evaluators	5.6	5.4	5.4	5.4	-3.1	-2.8	-3.4
Bank tellers	480.4	600.8	619.3	605.6	25.1	28.9	26.1
New accounts tellers	52.7	64.9	67	65.8	23.1	27.3	24.9
Tellers	427.7	535.9	552.3	539.9	25.3	29.1	26.2
Bookkeepers and accounting clerks	1,714.5	1,974.8	2,123.4	2,006.0	15.2	23.8	17.0
Accounting clerks	740.0	833.0	892.7	843.2	12.6	20.6	14.0
Bookkeepers, hand	974.6	1,141.8	1,230.7	1,162.8	17.2	26.3	19.3
Brokerage clerks	12.9	16.7	19.3	18.6	29.6	49.7	44.6
Car rental clerks	16.8	21.0	21.6	20.7	25.0	28.3	23.0
Cashiers	1,592.5	2,044.6	2,163.4	2,068.7	28.4	35.6	29.9
Checking clerks	15.9	20.3	20.9	20.4	27.4	31.5	28.1
Circulation clerks	10.7	12.7	13.6	13.0	18.4	27.5	21.9

See footnotes at end of table

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Claims adjusters	69.8	94.7	97.9	95.1	35.7	40.4	36.3
Claims clerks	67.6	92.3	95.8	92.8	36.5	41.6	37.2
Claims examiners, insurance	40.3	57.7	58.9	57.9	43.0	46.1	43.8
Clerical supervisors	429.6	518.7	552.7	526.0	20.8	28.7	22.4
Collectors, bill and account	88.7	107.9	119.0	112.8	21.6	34.1	27.1
Court clerks	26.0	30.4	30.9	30.4	16.9	19.0	17.2
Credit authorizers	20.8	25.6	27.0	26.3	23.1	29.9	26.5
Credit clerks, banking and insurance	50.4	61.9	68.0	66.0	22.7	34.8	31.0
Credit reporters	17.0	21.4	23.7	22.3	25.5	39.2	30.8
Customer service representatives, printing and publishing	7.0	7.9	8.6	8.1	13.4	23.2	16.8
Desk clerks, bowling floor	15.4	15.4	16.4	16.9	.4	6.4	10.2
Desk clerks, except bowling floor	82.3	94.1	106.4	95.3	14.3	29.2	15.8
Dispatchers, police, fire, and ambulance	51.0	59.6	60.7	59.7	17.0	19.0	17.2
Dispatchers, vehicle, service, or work	91.7	108.4	115.5	107.4	18.2	26.0	17.2
Eligibility workers, welfare	32.6	38.4	39.2	38.6	17.8	20.0	18.3
File clerks	270.9	325.0	346.2	329.1	19.9	27.8	21.5
General clerks, office	2,394.7	2,772.2	2,972.4	2,811.4	15.8	24.1	17.4
In-file operators	5.4	6.7	7.9	7.1	23.8	46.1	32.2
Insurance checkers	12.9	15.4	15.8	15.4	18.9	22.1	19.4
Insurance clerks, except medical	9.7	11.0	11.5	11.3	13.9	19.0	17.5
Insurance clerks, medical	69.0	92.8	97.4	92.2	34.5	41.2	33.7
Library assistants	119.0	123.3	124.7	123.3	3.7	4.8	3.7
Loan closers	24.1	31.1	32.7	31.9	29.2	35.8	32.3
Mail carriers, Postal Service	241.5	260.1	269.7	262.0	7.7	11.7	8.5
Mail clerks	81.2	94.5	99.4	96.2	16.4	22.4	18.5
Marking clerks, trade	43.5	53.8	56.8	54.8	23.8	30.6	26.1
Messengers	51.6	59.9	64.1	61.6	16.1	24.4	19.5
Meter readers, utilities	30.0	32.4	37.7	32.5	7.8	25.6	8.2
Mortgage closing clerks	21.8	24.7	26.7	26.4	13.3	22.4	21.3
Office machine operators	914.5	1,107.6	1,183.5	1,121.4	21.1	29.4	22.6
Bookkeeping and billing operators	233.8	283.5	301.1	282.5	21.2	28.8	20.9
Bookkeeping, billing machine operators	176.7	211.8	228.2	211.7	19.9	29.1	19.8
Proof machine operators	47.5	59.8	60.9	59.2	25.9	28.2	24.5
Transit clerks	9.6	11.8	12.0	11.7	23.5	25.7	22.3
Computer, peripheral equipment operators	233.2	386.8	412.0	393.9	65.8	76.6	68.9
Computer operators[1]	184.6	316.7	338.2	323.0	71.6	83.2	[illegible]
Peripheral EDP equipment operators	48.7	70.1	73.8	70.9	44.0	51.6	45.7
Duplicating machine operators	33.9	38.4	41.1	39.1	13.4	21.3	15.3
Keypunch operators	324.7	293.0	315.8	297.8	-9.8	-2.8	-8.3
Tabulating machine operators	5.1	6.0	6.4	6.1	17.3	25.1	19.1
All other office machine operators	83.7	100.0	107.2	101.9	19.4	28.1	21.7
Order clerks	250.2	289.0	316.0	288.1	15.5	26.3	15.1
Payroll and timekeeping clerks	178.7	210.9	226.2	214.2	18.0	26.6	19.9
Personnel clerks	94.8	111.4	117.5	112.7	17.5	23.9	18.8
Policy change clerks	26.6	31.6	33.1	31.7	19.0	24.5	19.4
Postal clerks	316.3	309.5	320.9	311.8	-2.2	1.5	-1.4
Procurement clerks	40.3	46.5	50.0	47.0	15.5	24.0	16.6
Production clerks	201.1	235.4	257.9	239.6	17.1	28.3	19.2
Proofreaders	19.8	22.2	24.2	23.1	12.5	22.3	16.9
Rate clerks, freight	11.2	13.9	14.4	13.4	24.1	29.2	19.9
Raters	56.1	63.2	65.9	63.5	12.6	17.4	13.2
Real estate clerks	15.6	22.1	23.8	22.0	41.6	52.1	40.5
Receptionists	401.5	499.0	533.0	504.8	24.3	32.7	25.7
Reservation agents	56.6	55.2	58.8	55.6	-2.4	3.9	-1.6
Safe deposit clerks	10.6	13.9	14.3	13.9	31.0	34.1	30.9
Secretaries, stenographers, and typists	3,817.4	4,680.9	4,996.2	4,760.2	22.6	30.9	24.7
Secretaries	2,469.0	3,168.7	3,392.0	3,227.5	28.3	37.4	30.7
Stenographers	281.2	257.9	274.6	261.7	-8.3	-2.3	-6.9
Typists	1,067.2	1,254.3	1,329.6	1,271.0	17.5	24.6	19.1
Service clerks	22.9	28.8	30.3	29.8	25.8	32.4	30.0
Shipping and receiving clerks	390.0	448.7	488.1	452.0	15.0	25.1	15.9
Shipping packers	346.1	397.8	431.2	400.9	15.0	24.6	15.8
Statement clerks	32.6	43.8	44.9	43.8	34.2	37.8	34.3
Statistical clerks	85.2	94.6	100.4	95.7	11.0	17.9	12.3
Stock clerks, stockroom and warehouse	821.6	963.7	1,042.7	977.3	17.3	26.9	18.9

See footnotes at end of table

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Survey workers	45.6	47.7	51.7	49.2	4.7	13.5	7.9
Switchboard operators/receptionists	233.4	275.7	297.9	281.7	18.1	27.6	20.7
Teachers' aides, except monitors	415.4	493.3	496.5	491.7	18.8	19.5	18.4
Telephone advertisement takers, newspapers	9.6	11.3	12.3	11.7	17.8	27.7	21.8
Telegraph operators	15.3	13.5	15.0	13.8	-11.8	-2.4	-10.0
Telephone operators	337.3	350.9	386.3	356.2	4.0	14.5	5.6
Switchboard operators	183.9	192.9	207.2	196.3	4.9	12.6	6.7
Central office operators	110.0	112.6	127.7	114.0	2.4	16.1	3.7
Directory assistance operators	38.0	39.7	45.0	40.2	4.5	18.4	5.8
All other telephone operators	5.4	5.7	6.4	5.8	5.0	19.0	6.4
Ticket agents	53.1	50.8	53.9	51.2	-4.2	1.6	-3.4
Title searchers	7.0	12.4	12.8	12.3	78.5	83.4	76.6
Town clerks	28.4	33.3	33.9	33.3	17.3	19.3	17.5
Traffic agents	18.2	21.8	22.9	21.3	19.8	25.8	17.1
Traffic clerks	6.7	8.8	9.1	8.8	31.5	36.9	31.8
Transportation agents	21.3	22.0	23.3	22.1	3.0	9.4	3.8
Travel counselors, auto club	8.4	9.9	10.8	10.1	16.9	28.0	19.7
Weighers	35.3	41.5	44.7	41.9	17.5	26.5	18.8
Worksheet clerks	11.6	12.5	12.6	12.5	7.7	9.2	8.2
Yard clerks	5.6	4.5	5.0	4.6	-18.6	-10.2	-17.6
All other clerical workers	1,150.0	1,339.1	1,437.1	1,360.2	16.4	25.0	18.3
Craft and related workers	12,369.2	14,566.9	15,756.1	14,866.3	17.8	27.4	20.2
Construction craft workers	3,317.1	3,981.2	4,276.6	4,076.0	20.0	28.9	22.9
Air-hammer operators	11.9	14.6	16.4	15.0	22.5	37.8	25.7
Brickmasons	145.9	204.5	220.5	211.2	40.2	51.2	44.8
Carpenters	969.5	1,142.7	1,231.0	1,186.4	17.9	27.0	22.4
Carpet cutters and layers	53.2	65.5	72.6	67.6	23.2	36.6	27.1
Ceiling tile installers and floor layers	26.6	34.8	38.4	35.9	31.0	44.2	35.1
Concrete and terrazzo finishers	112.6	154.1	166.0	158.9	36.9	47.4	41.1
Drywall installers and lathers	95.9	124.3	134.2	127.5	29.6	39.9	33.0
Drywall applicators	52.3	70.5	76.1	72.5	34.7	45.6	38.6
Lathers	11.9	11.4	12.2	11.7	-4.4	2.9	-1.7
Tapers	31.7	42.5	45.8	43.4	33.9	44.4	36.7
Electricians	560.3	669.4	717.0	684.1	19.5	28.0	22.1
Fitters, pipelaying	8.8	10.6	11.6	10.8	19.3	30.7	22.0
Glaziers	38.4	47.2	50.4	48.8	23.0	31.3	27.1
Highway maintenance workers	186.0	211.2	214.9	211.6	13.5	15.5	13.7
Insulation workers	45.4	59.3	63.4	60.9	30.5	39.6	34.1
Painters, construction and maintenance	382.4	435.8	476.6	429.3	14.0	24.6	12.3
Paperhangers	21.1	24.3	26.9	24.4	15.6	27.8	15.8
Plasterers	23.6	25.6	27.7	26.4	8.5	17.4	11.9
Plumbers and pipefitters	406.7	488.1	521.7	500.6	20.0	28.3	23.1
Refractory materials repairers	7.7	9.3	9.5	9.2	19.7	22.7	19.4
Roofers	112.6	129.6	139.4	133.6	15.2	23.8	18.7
Stonemasons	9.1	10.0	10.7	10.4	10.0	17.5	14.8
Structural steel workers	74.8	87.6	92.6	89.8	17.2	23.8	20.1
Tile setters	20.2	27.6	29.9	28.4	36.2	48.0	40.4
Mechanics, repairers, and installers	3,936.7	4,752.4	5,142.8	4,850.0	20.7	30.6	23.2
Air-conditioning, heating, and refrigeration mechanics	179.5	214.7	231.4	217.4	19.7	28.9	21.2
Aircraft mechanics	108.5	125.0	132.7	126.1	15.2	22.3	16.2
Auto body repairers	153.4	188.8	200.7	192.6	23.1	30.8	25.5
Auto seat cover and top installers	9.4	8.2	8.4	7.7	-12.7	-10.1	-18.1
Automotive mechanics	845.7	1,052.1	1,123.8	1,081.9	24.4	32.9	27.9
Auto repair service estimators	11.4	14.2	15.4	15.7	24.7	35.1	37.9
Bicycle repairers	12.4	15.7	17.3	15.1	27.1	39.7	22.5
Coin machine servicers and repairers	26.7	29.2	31.0	24.6	9.2	16.1	-8.0
Data processing machine mechanics	83.0	160.4	176.3	166.7	93.2	112.4	100.8
Diesel mechanics	173.5	214.4	227.6	214.5	23.5	31.1	23.6
Electrical instrument and tool repairers	9.1	10.7	11.7	11.1	16.8	27.7	21.6
Electric motor repairers	20.2	26.9	34.5	32.1	33.2	70.6	58.6
Electric powerline installers and repairers	171.6	187.0	212.0	189.8	9.0	23.6	10.6
Cable splicers	43.7	46.1	52.1	46.6	5.4	19.3	6.7
Line installers and repairers	120.2	132.7	150.3	134.8	10.4	25.1	12.2
Troubleshooters, powerline	7.7	8.2	9.6	8.3	6.6	24.5	7.9
Engineering equipment mechanics	92.0	104.0	112.3	107.6	13.1	22.1	17.0
Farm equipment mechanics	24.8	29.9	32.4	31.4	20.9	31.0	26.7

See footnotes at end of table.

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Gas and electric appliance repairers	60.2	67.7	75.5	67.7	12.4	25.3	12.4
Household appliance installers	17.0	22.0	23.9	22.8	29.0	40.4	33.5
Hydroelectric machine mechanics	13.0	13.9	15.8	14.0	7.6	22.1	8.2
Instrument repairers	37.6	41.5	44.9	41.9	10.5	19.6	11.6
Knitting machine fixers	10.6	11.1	12.2	10.8	5.4	14.9	2.0
Laundry machine mechanics	5.4	4.5	5.4	4.9	-17.4	-.1	-8.8
Locksmiths	11.4	15.6	18.8	17.7	37.2	65.7	55.6
Loom fixers	18.0	16.2	16.4	16.1	-9.9	-8.4	-10.4
Maintenance mechanics	348.1	411.0	439.5	418.9	18.1	26.3	20.3
Maintenance repairers, general utility	651.4	785.0	845.4	794.3	20.5	29.8	22.0
Marine mechanics and repairers	9.9	10.6	11.4	10.8	7.1	15.2	9.4
Millwrights	91.0	107.9	114.3	109.1	18.5	25.6	19.9
Mine machinery mechanics	18.1	26.4	29.9	28.1	46.0	65.4	55.3
Mobile home repairers	5.6	6.7	7.5	7.1	20.2	34.0	26.6
Musical instrument repairers	14.4	17.2	18.9	18.5	19.4	31.5	28.8
Office machine and cash register servicers	55.4	88.5	96.1	91.4	59.8	73.5	65.0
Pinsetter mechanics, automatic	6.5	6.6	6.9	7.2	.4	6.4	10.2
Radio and television repairers	83.1	109.1	118.6	114.3	31.3	42.8	37.6
Railroad car repairers	30.0	24.4	26.9	24.7	-18.5	-10.1	-17.5
Railroad signal and switch maintainers	5.7	4.7	5.1	4.7	-18.6	-10.2	-17.6
Section repairers and setters	13.6	14.0	14.4	13.7	3.0	6.1	1.3
Sewing machine mechanics	12.2	14.2	15.6	14.5	16.4	28.3	18.6
Shoe repairers	15.5	17.2	17.8	16.8	10.8	15.1	8.4
Telephone installers and repairers	247.6	265.9	301.5	269.6	7.4	21.8	8.9
Cable repairers	10.1	10.8	12.2	10.9	6.2	20.7	7.7
Cable installers	7.1	8.2	9.5	8.4	15.6	33.6	19.1
Central office repairers	50.8	47.8	54.2	48.4	-6.0	6.6	-4.8
Frame wirers	13.3	12.5	14.1	12.6	-6.0	6.5	-4.8
Installers, repairers, and section maintainers	75.0	86.5	98.0	87.7	15.4	30.7	16.9
Station installers	59.4	68.4	77.5	69.2	15.1	30.5	16.5
Trouble locators, test desk	19.4	18.3	20.7	18.5	-5.7	6.9	-4.5
All other telephone installers and repairers	12.5	13.6	15.3	13.8	8.4	22.4	10.4
Water meter installers	6.1	7.2	7.3	7.2	17.2	19.3	17.5
All other mechanics, repairers, and installers	224.0	257.4	279.8	264.1	14.9	24.9	17.9
Metalworking craft workers, except mechanics	936.1	1,069.7	1,179.6	1,094.2	14.3	26.0	16.9
Blacksmiths	5.9	5.4	6.0	5.6	-8.6	.8	-6.2
Boilermakers	43.9	48.3	52.7	50.1	10.1	20.1	14.2
Coremakers, hand, bench, and floor	9.3	10.3	10.9	10.3	10.8	17.9	11.4
Forging press operators	8.9	10.8	12.0	11.1	21.6	34.6	24.9
Header operators	5.4	6.9	7.4	7.0	27.6	37.9	30.7
Heat treaters, annealers, and temperers	25.2	29.5	32.0	29.6	17.0	26.8	17.6
Layout markers, metal	21.3	24.3	27.2	24.8	13.9	28.0	16.7
Machine tool setters, metalworking	55.5	65.9	73.7	67.3	18.6	32.7	21.1
Machinists[1]	281.9	326.7	362.3	335.4	15.9	28.5	19.0
Molders, metal	39.7	44.3	47.0	44.3	11.6	18.5	11.6
Molders, bench and floor	13.0	14.5	15.5	14.6	11.9	19.6	12.5
Molders, machine	19.2	21.6	23.1	21.7	12.5	20.6	13.5
All other molders, metal	7.5	8.2	8.3	7.9	8.9	11.4	5.5
Patternmakers, metal	7.9	9.4	10.3	9.5	19.0	29.6	20.1
Punch press setters, metal	19.2	23.3	25.9	23.9	21.4	34.6	24.1
Rolling mill operators and helpers	10.8	12.4	12.7	12.4	15.4	17.5	14.5
Shear and slitter setters	5.5	6.6	7.2	6.7	20.1	32.0	22.1
Sheet-metal workers and tinsmiths[1]	217.8	252.1	270.7	258.1	15.7	24.3	18.5
Tool-and-die makers	166.0	179.1	206.4	183.6	7.9	24.4	10.6
All other metalworking craft workers	11.9	14.4	15.2	14.5	21.4	28.0	22.6
Printing trades craft workers	408.0	429.8	463.0	444.9	5.3	13.5	9.0
Bookbinders, hand and machine	23.7	26.4	28.7	27.4	11.4	21.2	15.9
Bindery machine setters	6.5	7.1	7.7	7.4	10.4	20.1	14.8
Compositors and typesetters	127.8	115.5	124.8	119.0	-9.6	-2.3	-6.9
Etchers and engravers	14.7	16.9	18.0	17.1	14.8	22.2	16.1
Photoengravers and lithographers	55.1	68.6	74.2	71.5	24.4	34.6	29.7
Camera operators, printing	22.2	29.3	31.7	30.5	32.1	43.0	37.6
Photoengravers	10.3	9.9	10.6	10.3	-4.7	3.0	-.8
Strippers, printing	22.6	29.5	31.9	30.8	30.1	40.9	35.8

See footnotes at end of table

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Press and plate printers	178.3	194.2	208.3	201.3	9.0	16.9	12.9
Letter press operators	38.0	37.0	40.0	38.6	-2.8	5.1	1.4
Offset lithographic press operators	80.8	92.3	99.4	96.1	14.3	23.0	19.0
Platemakers	13.8	15.0	16.2	15.6	8.4	17.3	12.9
Press operators and plate printers	36.1	39.9	41.9	40.5	10.5	15.9	12.2
All other press and plate printers	9.5	10.0	10.8	10.5	6.1	14.7	10.8
Other craft and related workers	3,771.4	4,333.8	4,694.0	4,401.3	14.9	24.5	16.7
Auxiliary equipment operators	8.3	8.0	9.2	8.0	-3.7	11.1	-3.2
Bakers	63.2	72.2	76.5	73.9	14.2	20.9	16.9
Blue-collar worker supervisors	1,297.0	1,503.1	1,624.8	1,528.3	15.9	25.3	17.8
Cabinetmakers	70.7	89.3	95.1	88.1	26.2	34.5	24.6
Control room operators, steam	7.6	7.2	8.4	7.3	-5.4	9.7	-4.3
Crane, derrick, and hoist operators	126.6	144.3	154.3	146.9	14.1	21.9	16.0
Dental laboratory technicians	53.4	68.9	79.4	70.6	29.0	48.7	32.3
Food shapers, hand	5.1	4.5	4.9	4.7	-11.4	-5.2	-8.6
Furniture finishers	22.1	26.0	28.6	26.4	17.6	29.4	19.7
Furniture upholsterers	34.8	35.9	40.0	37.1	3.4	15.0	6.7
Glass installers	5.7	7.9	8.1	7.3	38.6	41.8	28.5
Heavy equipment operators	452.8	531.3	582.4	545.0	17.3	28.6	20.3
Inspectors	472.5	544.2	595.1	553.9	15.2	26.0	17.2
Jewelers and silversmiths	27.8	32.2	35.3	31.2	15.9	27.2	12.3
Lens grinders	10.9	12.6	14.0	13.2	14.9	28.4	20.6
Locomotive engineers	46.8	46.7	51.2	47.3	-.2	9.3	.9
Locomotive engineer helpers	11.0	4.4	4.8	4.4	-60.1	-56.0	-59.6
Log inspectors, graders, and scalers	5.3	5.6	5.7	5.5	5.5	7.0	3.7
Logging tractor operators	25.8	15.4	16.1	15.7	-40.1	-37.7	-39.0
Lumber graders	5.8	6.2	6.2	6.0	8.5	8.4	3.4
Machine setters, paper goods	10.0	10.1	10.3	10.2	1.3	3.5	2.2
Machine setters, plastic materials	7.4	9.6	9.8	9.4	28.8	31.3	26.7
Machine setters, woodworking	5.1	6.4	6.5	6.1	24.4	27.8	19.3
Merchandise displayers and window trimmers	26.1	30.9	33.2	31.7	18.5	27.0	21.3
Millers	6.5	7.2	7.7	7.2	10.4	17.9	11.0
Motion picture projectionists	19.3	19.7	19.5	19.2	1.9	.7	-.8
Opticians	33.4	42.1	45.7	40.8	26.1	36.9	22.5
Oil pumpers	15.1	16.1	17.0	15.8	6.7	12.3	4.6
Patternmakers, wood	7.4	8.7	9.6	8.8	17.9	29.5	19.1
Power station operators	17.9	19.4	21.6	19.6	8.4	20.5	9.3
Pumpers, head	8.4	8.8	9.2	8.6	4.2	9.7	2.1
Pumping station operators, waterworks	5.2	6.4	6.7	6.4	21.4	27.7	21.7
Sewage plant operators	41.2	43.3	44.5	43.4	5.0	8.0	5.3
Shipfitters	17.1	20.8	23.1	21.4	21.7	35.2	25.5
Ship engineers	9.6	10.4	10.8	9.8	6.1	9.6	-.6
Stationary engineers	62.3	71.0	75.0	71.6	14.0	20.3	14.9
Tailors	62.8	75.5	82.6	77.1	20.3	31.5	22.8
Testers	105.7	119.8	129.5	121.8	13.3	22.5	15.2
Upholsterers	20.9	26.2	28.7	26.5	25.6	37.7	26.9
Upholstery cutters	6.8	8.4	9.1	8.5	23.2	33.9	25.2
Upholstery workers, n.e.c.	15.5	18.7	20.3	19.0	20.9	30.9	22.7
Veneer graders	5.1	6.3	5.9	5.3	22.4	14.5	3.9
Watchmakers	12.3	12.4	13.9	12.2	.9	12.9	-.9
Water treatment plant operators	29.7	34.9	36.3	35.0	17.4	22.3	17.7
All other craft and related workers	463.1	529.9	572.6	539.3	14.4	23.6	16.4
Operatives	14,206.1	16,304.9	17,595.8	16,487.3	14.8	23.9	16.1
Assemblers	1,668.4	1,989.5	2,183.1	2,021.1	19.2	30.9	21.1
Aircraft structure and surfaces assemblers	25.4	26.7	29.4	27.2	5.2	15.8	7.0
Electrical and electronic assemblers	233.1	272.7	299.1	276.5	17.0	28.3	18.6
Electro-mechanical equipment assemblers	58.4	69.3	78.1	70.5	18.8	33.9	20.9
Instrument makers and assemblers	24.8	29.2	33.1	28.9	17.7	33.2	16.4
Machine assemblers	103.0	124.2	144.0	126.9	20.6	39.8	23.2
All other assemblers	1,219.3	1,462.2	1,593.6	1,486.1	19.9	30.7	21.9
Bindery operatives	86.6	78.9	85.6	81.9	-8.9	-1.1	-5.3
Bindery workers, assembly	43.7	39.2	42.6	40.8	-10.4	-2.6	-6.8

See footnotes at end of table.

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Bindery workers, stitching	10.4	10.1	11.0	10.5	-3.5	5.0	0.2
All other bindery operatives	32.4	29.6	32.1	30.7	-8.6	-1.1	-5.2
Laundry, drycleaning, and pressing machine operators	324.6	355.6	[illegible]03.9	375.2	9.6	24.4	15.6
Drycleaners, hand and machine	14.6	13.9	16.8	15.3	-5.1	15.0	4.8
Folders, laundry	15.8	13.0	15.8	14.4	-17.7	.1	-8.8
Laundry operators, small establishment	40.0	47.6	53.2	49.4	19.2	33.2	23.6
Markers, classifiers, and assemblers	18.1	15.9	18.4	17.2	-12.0	1.8	-5.0
Pressers, hand	29.3	32.3	36.0	33.4	10.1	22.5	13.8
Pressers, machine	53.3	55.8	64.7	59.2	4.6	21.4	11.1
Pressers, machine laundry	67.5	73.8	83.6	78.0	9.3	23.9	15.5
Rug cleaners, hand and machine	6.7	5.5	6.7	6.1	-17.3	.6	-8.4
Shapers and pressers	6.0	6.5	7.3	6.7	9.1	21.9	11.6
Spotters, drycleaning and washable materials	7.2	5.9	7.2	6.6	-17.8	-.1	-9.0
Washers, machine, and starchers	59.1	78.6	86.6	81.8	32.9	46.4	38.4
All other laundry, drycleaning, and pressing machine operators	6.9	6.7	7.5	7.1	-2.8	10.0	3.1
Meat cutters and butchers	66.3	67.3	71.7	66.5	1.4	8.2	.3
Boners, meat	17.0	17.7	18.8	17.3	4.0	10.7	1.5
Boners, poultry	10.3	10.8	11.5	10.6	4.1	10.7	2.0
Butchers, all-around	22.9	23.8	25.3	23.1	3.9	10.7	1.2
Carcass splitters	6.8	7.0	7.5	6.8	4.0	10.6	1.1
Fish cleaners, hand, and butchers, fish	9.3	8.0	8.7	8.7	-14.2	-7.2	-6.9
Metalworking operatives	1,652.8	1,970.4	2,211.2	2,025.4	19.2	33.8	22.5
Dip platers, nonelectrolytic	13.1	15.6	16.7	15.8	19.1	27.3	20.8
Drill press and boring machine operators	124.5	147.6	167.1	151.3	18.6	34.2	21.6
Electroplators	37.5	44.1	47.7	45.1	17.7	27.3	20.4
Furnace chargers	5.5	6.7	6.8	6.6	20.3	22.4	19.7
Furnace operators, cupola tenders	16.9	19.8	20.8	19.8	17.2	23.4	17.1
Grinding and abrading machine operators, metal	131.4	153.9	173.4	157.2	17.1	32.0	19.7
Heaters, metal	6.5	7.7	8.3	7.9	18.9	27.1	20.8
Lathe machine operators, metal	156.6	186.3	210.2	191.3	19.0	34.2	22.1
Machine-tool operators, combination	170.7	199.9	226.2	205.9	17.1	32.5	20.6
Machine-tool operators, numerical control	52.7	61.2	69.7	62.8	16.1	32.3	19.2
Machine-tool operators, tool-room	38.7	45.6	52.1	46.7	17.9	34.6	20.6
Milling and planing machine operators	72.4	83.1	95.4	85.6	14.8	31.9	18.3
Pourers, metal	15.3	19.4	20.3	19.4	26.7	32.7	26.9
Power brake and bending machine operators, metal	40.1	48.4	53.9	49.4	21.0	34.5	23.3
Punch press operators, metal	182.9	217.4	240.4	222.3	18.8	31.4	21.5
Welders and flamecutters	572.8	696.2	784.3	720.8	21.6	36.9	25.8
All other metalworking operatives	15.2	17.5	17.9	17.3	15.2	17.6	13.9
Mine operatives, n.e.c.	210.3	238.5	258.3	242.7	13.4	22.8	15.4
Continuous mining machine operators	8.5	13.1	15.1	14.2	54.5	77.4	66.8
Derrick operators, petroleum and gas	16.7	15.9	16.7	15.7	-4.7	.0	-6.0
Gagers	7.3	7.6	7.9	7.4	3.0	7.7	.4
Loading machine operators	7.1	9.3	10.4	9.7	31.7	46.9	36.8
Mill and grinder operators, minerals	12.0	13.3	14.0	13.1	10.6	16.4	8.9
Roof bolters	12.7	17.7	20.3	19.1	39.8	60.3	50.9
Roustabouts	79.8	79.7	83.7	78.5	.0	4.9	-1.5
Service unit operators, oil well	12.0	12.3	12.9	12.1	2.3	7.3	.9
Shuttle car operators	13.3	18.2	20.9	19.6	37.2	57.3	47.8
Well pullers	6.6	6.8	7.1	6.7	3.4	8.5	1.8
All other mine operatives, n.e.c.	34.5	44.6	49.4	46.7	29.3	43.3	35.3
Packing and inspecting operatives	919.2	980.7	1,040.7	993.0	6.7	13.2	8.0
Baggers	235.1	237.7	249.9	242.3	1.1	6.3	3.0
Bundlers	19.0	20.6	22.8	21.1	8.3	19.6	10.9
Cloth graders	8.4	8.5	8.7	8.4	1.8	4.6	.7
Graders, food and skins	6.6	6.6	7.1	6.9	1.4	7.9	4.9
Production packagers	608.9	660.6	704.3	669.3	8.5	15.7	9.9
Selectors, glassware	30.1	34.8	35.4	33.2	15.5	17.7	10.1
All other packing and inspecting operatives	11.1	11.8	12.4	11.9	5.9	11.2	7.2
Painters, manufactured articles	161.8	204.9	221.6	205.9	26.6	36.9	27.3
Painters, automotive	40.7	56.2	58.6	55.1	38.1	43.9	35.4
Decorators, hand	5.4	7.1	7.6	7.3	31.8	40.2	35.5
Rubbers	7.3	9.5	10.1	9.5	29.9	39.0	30.3

See footnotes at end of table

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Painters, production	108.4	132.1	145.3	134.0	21.8	34.0	23.6
Sawyers	83.1	98.2	102.2	97.5	18.2	22.9	17.3
Cut-off-saw operators, lumber	17.5	21.6	22.1	20.8	23.6	26.0	19.1
Edgers, automatic and pony	6.0	6.5	6.6	6.3	8.2	9.6	5.4
Head sawyers	6.5	7.1	7.2	6.9	8.9	10.1	6.1
Ripsaw operators	12.4	15.3	15.8	14.9	23.7	28.2	20.7
Sawyers, metal	19.1	22.9	25.4	23.3	19.9	32.6	21.9
Trim-saw operators	6.5	7.3	7.3	7.0	12.1	12.3	8.0
All other sawyers	15.1	17.5	17.8	18.2	15.7	18.0	20.1
Sewers and stitchers	895.3	967.5	1,065.8	987.3	8.1	19.0	10.3
Menders	9.8	9.5	11.4	10.4	-3.2	16.8	6.3
Sewing machine operator							
Regular equipment, garment	602.0	633.9	702.0	647.4	5.3	16.6	7.5
Special equipment, garment	87.0	96.3	106.4	98.5	10.8	22.4	13.2
Regular equipment, nongarment	137.7	161.8	175.0	164.0	17.5	27.1	19.1
Special equipment, nongarment	38.9	45.5	49.0	46.1	16.9	25.9	18.3
All other sewers and stitchers	15.1	15.3	16.1	15.6	1.1	6.2	3.4
Textile operatives	380.2	399.0	419.3	395.9	4.9	10.3	4.1
Battery loaders	8.3	6.4	6.5	6.4	-22.5	-21.4	-22.7
Beam warper tenders and beamers	10.0	9.4	9.9	9.6	-5.9	-.6	-4.1
Card tenders and comber tenders	9.9	10.3	10.8	10.1	4.2	9.0	2.6
Creelers, yarn	17.6	19.6	20.7	19.7	11.3	17.8	11.8
Doffers	24.3	24.4	25.2	24.3	.3	3.7	-.1
Drawing frame and gill box tenders	7.7	8.5	8.7	8.3	10.1	12.8	8.0
Folders, hand	26.2	29.4	32.3	29.5	12.1	23.1	12.7
Knitting machine operators	22.0	23.4	25.5	22.8	6.2	15.7	3.5
Seamless hosiery knitters	5.2	5.5	6.0	5.3	5.0	15.1	1.4
Slubber tenders	5.5	5.5	5.6	5.4	-1.1	1.3	-2.7
Spinners, frame	30.6	31.6	32.4	31.0	3.2	6.0	1.2
Spooler operators, automatic	7.6	6.9	7.1	6.9	-9.4	-7.3	-10.3
Texturizers and crimp setters	7.5	8.7	9.1	8.8	15.2	20.9	17.0
Turners	10.3	11.0	12.2	11.3	6.9	18.0	9.2
Twister tenders	14.4	17.4	18.1	17.2	21.0	25.9	19.9
Weavers	35.2	32.5	33.4	32.4	-7.5	-5.1	-7.8
Winder operators, automatic	13.4	15.6	16.1	15.2	16.2	20.0	13.8
Yarn winders	19.9	23.7	24.5	23.4	19.1	23.3	17.5
All other textile operatives	85.9	89.0	93.5	88.3	3.6	8.9	2.8
Transportation equipment operatives	3,527.6	4,153.5	4,430.1	4,141.4	17.7	25.6	17.4
Ambulance drivers and ambulance attendants	31.3	41.4	42.4	40.1	32.2	35.4	28.2
Bus drivers	285.3	325.0	328.3	320.1	13.9	15.1	12.2
Chauffeurs	42.0	48.2	51.9	48.3	14.6	23.4	14.8
Delivery and route workers	825.7	917.1	991.4	901.6	11.1	20.1	9.2
Industrial truck operators	399.9	459.3	492.8	463.8	14.8	23.2	16.0
Log handling equipment operators	7.5	7.7	7.7	7.5	3.5	3.5	.3
Parking attendants	35.8	44.5	51.3	57.9	24.2	43.3	61.6
Railroad brake operators	74.1	66.7	73.4	67.6	-10.0	-.9	-8.7
Rental car delivery workers	9.4	12.1	12.4	11.9	29.1	32.3	26.8
Sailors and deckhands	33.8	34.6	35.7	30.9	2.1	5.5	-8.5
Streetcar operators	8.2	9.6	9.8	9.6	17.3	19.3	17.5
Taxi drivers	71.2	69.1	78.4	72.0	-3.0	10.0	1.0
Truck drivers	1,696.3	2,111.5	2,247.6	2,103.6	24.5	32.5	24.0
Transportation equipment operatives, n.e.c.	7.1	6.6	7.1	6.6	-6.3	-.2	-6.6
All other operatives	4,229.9	4,801.0	5,102.3	4,853.5	13.5	20.6	14.7
Batch plant operators	8.0	9.7	10.3	10.2	21.1	29.0	27.2
Blasters	9.1	11.6	12.9	12.0	28.3	42.5	32.7
Coil finishers	7.4	8.9	9.7	9.1	19.6	30.4	21.9
Cutters, machine	28.8	31.9	33.9	32.5	10.6	17.7	12.6
Cutters, portable machine	16.9	18.3	20.1	18.6	8.1	19.0	9.9
Cutter-finisher operators, rubber goods	7.4	9.3	9.4	9.4	26.0	26.8	27.2
Cutting machine operators, food	12.0	11.5	12.3	11.7	-4.0	2.3	-2.4
Die cutters and clicking machine operators	20.2	21.2	22.3	21.4	4.9	10.6	6.1
Dressmakers, except factory	46.0	48.9	53.1	50.5	6.4	15.4	9.8
Drillers, hand and machine	18.2	24.1	26.7	25.0	32.8	46.8	37.4
Dyers	13.4	15.0	15.9	14.9	12.2	18.3	10.9
Exterminators	25.6	33.7	37.4	35.2	31.6	46.2	37.5
Filers, grinders, buffers, and chippers	125.2	151.4	168.5	155.3	20.9	34.6	24.1

See footnotes at end of table.

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Psychiatric aides	82.4	115.3	120.5	115.6	39.9	46.1	40.2
Selected personal service workers	1,660.3	1,979.0	2,153.4	2,057.9	19.2	29.7	23.9
Barbers	112.2	120.4	137.3	126.8	7.3	22.4	13.1
Baggage handlers and porters	5.8	5.1	5.6	5.2	-11.7	-4.2	-10.9
Bellhops, bag porters, and doorkeepers	26.6	28.5	31.7	28.7	7.2	19.2	7.9
Checkroom and locker room attendants	9.9	12.2	13.1	12.3	23.5	32.3	24.2
Child care attendants	41.0	55.4	59.6	59.1	35.3	45.3	44.2
Child care workers, except private household	455.3	580.3	613.9	598.8	27.4	34.8	31.5
Cosmetologists and women's hairstylists[1]	466.1	529.0	600.9	564.5	13.5	28.9	21.1
Elevator operators	48.9	59.4	64.1	60.1	21.5	31.0	23.0
Flight attendants	55.9	64.1	68.0	64.5	14.6	21.6	15.4
Funeral attendants	10.4	10.6	12.7	11.7	1.8	22.9	13.0
Game and ride operators and concession workers	29.3	37.0	37.8	36.0	26.2	28.8	22.8
Guides, sightseeing and establishment	7.1	8.5	8.8	8.2	20.2	24.9	15.8
Housekeepers, hotel and motel	50.1	66.6	74.1	68.7	33.0	48.0	37.1
Manicurists	16.3	18.4	21.1	19.8	12.9	29.3	20.9
Masseurs and masseuses	6.2	6.8	8.1	7.5	9.2	30.9	20.9
Pin chasers	9.3	9.3	9.9	10.2	.5	6.4	10.2
Recreation facility attendants	68.9	82.9	85.3	82.5	20.3	23.7	19.7
Reducing instructors	27.7	28.9	35.0	32.3	4.4	26.4	16.5
Scalp treatment operators	9.7	12.2	14.1	13.1	26.6	45.6	35.8
School monitors	36.9	37.4	37.6	37.3	1.5	1.8	1.2
Shampooers	21.5	24.3	27.8	26.1	13.3	29.5	21.3
Ushers, lobby attendants, and ticket takers	41.4	46.3	45.9	45.7	11.9	11.0	10.4
Welfare service aides	94.5	126.4	131.5	129.8	33.8	39.2	37.4
Personal service workers, n.e.c.	9.4	8.6	9.6	9.0	-8.3	1.5	-4.8
Protective service workers	1,751.3	2,122.5	2,214.6	2,144.6	21.2	26.5	22.5
Bailiffs	8.3	9.7	9.8	9.7	17.1	19.1	17.3
Checkers, fitting room	8.9	11.3	11.8	11.7	27.1	33.0	32.1
Correction officials and jailers	103.4	151.6	154.2	151.8	46.5	49.1	46.8
Crossing or bridge tenders	29.3	32.3	33.0	32.3	10.4	12.9	10.5
Crossing guards, school	41.3	48.5	49.3	48.6	17.3	19.3	17.5
Firefighters	219.2	255.8	260.3	256.2	16.7	18.8	16.9
Fire inspectors	5.9	6.9	7.0	6.9	17.2	19.3	17.4
Fire officers	50.4	59.1	60.2	59.2	17.3	19.3	17.5
Fish and game wardens	6.5	7.3	7.4	7.3	13.0	14.9	13.1
Guards and doorkeepers	648.1	800.7	867.3	819.6	23.5	33.8	26.5
Lifeguards	19.5	25.0	26.2	24.4	28.1	34.3	25.4
Parking enforcement officers	7.4	8.7	8.8	8.7	17.3	19.3	17.5
Police detectives	63.3	72.2	73.5	72.3	14.0	16.1	14.2
Police officers	102.2	118.6	120.7	118.8	16.0	18.1	16.2
Police patrolmen/women	393.0	458.9	467.0	459.7	16.8	18.8	17.0
Sheriffs	22.2	26.1	26.5	26.1	17.3	19.3	17.5
Store detectives	18.3	26.1	27.4	27.1	42.8	49.7	48.1
Private household workers	988.4	980.7	992.5	987.0	-.8	.4	-.1
Child care workers, private household	393.7	411.2	416.2	413.8	4.4	5.7	5.1
Cooks, private household	23.2	18.5	18.7	18.6	-20.1	-19.2	-19.6
Housekeepers, private household	86.7	99.7	100.9	100.4	15.1	16.4	15.8
Laundresses, private household	6.4	2.2	2.3	2.3	-64.9	-63.5	-64.3
Maids and servants, private household	478.4	449.0	454.4	451.9	-6.1	-5.0	-5.5
Supervisors, nonworking, service	203.9	254.2	269.6	256.0	24.6	32.2	25.5
All other service workers	518.3	629.8	666.2	637.2	21.5	28.6	22.9
Laborers, except farm	5,859.8	6,668.2	7,144.6	6,790.5	13.8	21.9	15.9
Animal caretakers	94.4	112.5	121.8	123.9	19.3	29.1	31.3
Construction laborers, except carpenter helpers	101.6	122.2	133.1	124.9	20.2	30.9	22.9
Asphalt rakers	6.8	7.9	9.4	8.1	15.1	37.4	18.2
Fence erectors	6.9	8.8	9.3	9.0	27.3	34.2	30.5
Pipelayers	46.0	54.5	60.0	55.5	18.4	30.5	20.6
Reinforcing-iron workers	34.2	41.7	43.9	42.8	21.8	28.2	25.0
All other construction laborers	7.7	9.3	10.5	9.6	21.7	36.7	25.0
Cannery workers	75.6	79.5	84.2	88.8	5.2	11.4	17.5
Chain offbearers, lumber	22.0	23.9	23.9	22.7	8.5	8.5	3.2
Cleaners, vehicle	116.4	148.3	157.6	158.4	27.4	35.4	36.1
Conveyor operators and tenders	53.3	62.5	68.0	63.5	17.2	27.7	19.1
Forest conservation workers	13.7	14.7	15.1	14.8	7.8	10.1	8.2

See footnotes at end of table.

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Floor sanding machine operators	12.3	10.9	12.2	11.4	-11.3	-1.2	8
Fuel pump attendants and lubricators	401.3	475.1	491.9	481.4	18.4	22.6	[illegible]
Furnace operators and tenders, except metal	62.0	64.6	67.2	64.6	4.2	8.4	4.2
Kiln operators, minerals	7.4	7.6	7.9	7.5	2.6	7.7	1.2
Stationary boiler firers	48.4	50.5	52.5	50.7	4.4	8.5	4.7
All other furnace operators and tenders, except metal	6.2	6.5	6.7	6.5	4.8	8.3	4.1
Furniture assemblers and installers	8.8	10.8	11.5	10.8	21.9	30.8	22.6
Miscellaneous machine operatives							
Meat and dairy	47.9	45.6	48.6	44.7	-4.8	1.3	-6.7
All other food	73.6	78.5	83.3	80.9	6.7	13.2	9.9
Tobacco	7.6	7.1	7.8	7.3	-5.8	3.8	[illegible]
Lumber and furniture	47.5	58.9	60.0	55.6	23.8	26.2	17.0
Paper	106.5	117.8	120.3	118.9	10.5	13.0	11.6
Chemicals	153.4	166.6	175.9	172.2	8.6	14.6	12.3
Rubber and plastics	218.4	283.5	291.9	282.2	29.8	33.7	29.2
Leather	8.2	8.2	8.7	8.3	.1	5.8	1.5
Stone, clay, glass	47.1	53.2	55.9	53.7	12.9	18.8	14.0
Primary metals	85.6	100.2	105.8	100.5	17.1	23.6	17.3
Manufacturing, n.e.c.	87.9	101.9	107.3	102.7	15.9	22.1	16.8
Nonmanufacturing, n.e.c.	40.0	42.9	45.6	42.2	7.2	14.2	5.5
Miscellaneous operatives, durable goods, n.e.c.	99.1	122.9	128.4	122.5	24.0	29.5	23.6
Miscellaneous operatives, nondurable goods, n.e.c.	250.8	257.2	275.6	258.7	2.6	9.9	3.2
Mixing operatives	51.5	51.3	54.9	51.9	-.3	6.5	.8
Nailing machine operators	9.4	11.0	10.9	10.9	16.7	15.7	15.7
Oilers	40.9	48.2	52.4	49.0	17.9	28.2	20.0
Photographic process workers	76.6	81.2	89.1	81.0	6.0	16.2	5.7
Power screwdriver operators	8.5	10.6	11.3	10.6	23.6	32.3	23.7
Punch and stamping press operators, except metal	5.3	6.5	6.8	6.4	23.4	29.2	21.4
Riveters	14.2	17.2	18.7	17.6	20.8	31.5	23.7
Rotary drill operators	22.6	24.2	25.5	24.0	7.2	13.0	6.3
Rotary drill operator helpers	39.7	42.3	44.6	42.0	6.6	12.4	5.7
Sandblasters and shotblasters	11.6	14.3	15.5	14.4	22.6	33.1	24.1
Sanders, wood	20.9	26.5	28.0	26.1	26.7	33.6	24.5
Shear and slitter operators, metal	31.2	37.0	40.5	37.8	18.6	29.9	21.2
Shoemaking machine operators	64.9	54.1	58.8	54.6	-16.5	-9.3	-15.8
Surveyor helpers	55.8	67.3	69.8	68.0	20.7	25.2	22.0
Termite treaters and helpers	8.8	11.6	12.9	12.1	32.6	47.7	38.7
Tire changers and repairers	60.7	70.9	76.8	73.0	16.8	26.4	20.2
Winding operatives, n.e.c.	49.6	58.0	62.1	59.0	17.0	25.2	19.0
Coil winders	31.0	36.8	40.4	37.6	18.8	30.2	21.3
Paper reel and rewinder operators	5.5	6.1	6.2	6.1	10.3	11.2	10.1
Winders, paper machine	5.7	6.3	6.3	6.3	10.6	11.1	10.4
All other winding operatives, n.e.c.	7.4	8.8	9.2	9.0	19.4	25.3	22.7
Wirers, electronic	30.7	35.1	38.4	36.2	14.4	25.1	17.7
Wood machinists	25.5	32.9	34.0	32.4	28.7	33.0	27.0
Operatives, n.e.c.	1,488.2	1,678.5	1,798.9	1,701.7	12.8	20.9	14.3
Service workers	15,547.1	19,103.4	20,233.6	19,374.1	22.9	30.1	24.6
Food service workers	6,183.5	7,771.0	8,189.2	7,824.6	25.7	32.4	26.5
Bakers, bread and pastry	48.1	56.6	59.3	57.0	17.6	23.2	18.3
Bartenders	382.2	452.8	479.6	457.3	18.5	25.5	19.6
Butchers and meat cutters	190.0	211.6	224.5	213.9	11.4	18.2	12.6
Cooks, except private households	1,122.5	1,365.1	1,436.5	1,377.8	21.6	28.0	22.7
Cooks, institutional	[illegible]	368.9	385.1	376.3	18.6	23.8	21.0
Cooks, restaurant	355.7	444.7	471.0	447.7	25.0	32.4	25.9
Cooks, short order and specialty fast foods	455.7	551.5	580.3	553.8	21.0	27.3	21.5
Food service workers, fast food restaurants	806.3	1,206.3	1,265.3	1,210.1	49.6	56.9	50.1
Hosts/hostesses, restaurants, lounges, and coffee shops	116.1	154.3	163.1	154.7	32.9	40.5	33.2
Kitchen helpers	839.4	1,070.7	1,130.4	1,082.6	27.6	34.7	29.0
Pantry, sandwich, and coffee makers	71.4	91.6	97.2	91.8	28.4	36.2	28.6
Waiters and waitresses	1,711.3	2,071.6	2,187.6	2,084.9	21.1	27.8	21.8
Waiters, assistants	280.3	362.6	384.0	365.9	29.4	37.0	30.5
All other food service workers	615.9	727.8	761.5	728.7	18.2	23.6	18.3
Janitors and sextons	2,751.2	3,252.5	3,499.9	3,312.8	18.2	27.2	20.4
Selected health service workers	1,490.2	2,113.8	2,248.2	2,154.0	41.8	50.9	44.5
Dental assistants	138.8	193.4	197.6	191.4	39.4	42.4	38.0
Health aides, except nursing	5.0	6.6	7.0	6.8	31.8	38.9	35.0
Medical assistants	89.4	116.3	122.8	115.7	30.1	37.3	29.5
Nurses aides and orderlies	1,174.6	1,682.3	1,800.3	1,724.5	43.2	53.3	46.8

See footnotes at end of table.

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Table C-1. Employment, 1980 and projected 1990 (three alternatives), and percent change, 1980-90 in occupations with 1980 employment of 5,000 or higher—Continued

(Thousands)

Occupation	Employment, all industries				Percent change		
	1980	1990 (Low)	1990 (High I)	1990 (High II)	1980-90 (Low)	1980-90 (High I)	1980-90 (High II)
Furnace operators and heater helpers	8.3	9.8	10.3	9.8	18.0	23.5	17.8
Garbage collectors	117.3	136.5	147.5	136.5	16.4	25.8	16.4
Gardeners and groundskeepers, except farm	652.5	737.7	788.3	764.1	13.1	20.8	17.1
Helpers, trades	954.8	1,167.1	1,261.8	1,199.3	22.2	32.2	25.6
Line service attendants	30.3	31.8	33.9	32.0	4.7	11.6	5.5
Loaders, cars and trucks	6.2	7.6	7.4	7.2	21.5	17.8	15.1
Loaders, tank cars and trucks	8.8	9.6	10.3	10.3	10.2	17.9	17.8
Off-bearers	23.6	27.9	28.2	26.5	18.2	19.3	12.0
Riggers	28.3	33.1	35.3	33.8	16.9	24.6	19.5
Septic tank servicers	6.1	8.1	10.7	10.0	32.0	75.2	63.6
Setters and drawers	7.2	7.5	7.8	7.4	5.1	9.4	2.8
Shakeout workers, foundry	10.6	13.8	14.5	13.8	30.4	37.1	30.4
Stock handlers	965.0	1,127.4	1,206.5	1,133.1	16.8	25.0	17.4
Order fillers	363.7	405.9	443.3	404.3	11.6	21.9	11.2
Stock clerks, sales floor	601.3	721.5	763.2	728.9	20.0	26.9	21.2
Timbercutting and logging workers	74.6	59.1	62.7	60.8	-20.8	-16.0	-18.5
Choker setters, lumber	11.4	8.9	9.5	9.2	-22.0	-17.1	-19.5
Fallers and buckers	46.0	36.3	38.5	37.3	-21.2	-16.4	-19.0
All other timbercutting and logging workers	17.2	14.0	14.8	14.3	-18.6	-14.0	-16.6
Work distributors	17.7	20.8	22.9	21.4	17.7	29.6	20.7
All other laborers, except farm	2,471.4	2,706.6	2,892.7	2,727.4	9.5	17.0	10.4
Farmers and farm workers	2,689.2	2,193.1	2,426.3	2,327.4	-18.4	-9.8	-13.5
Farmers and farm managers	1,484.2	1,230.6	1,354.9	1,281.3	-17.1	-8.7	-13.7
Farmers (owners and tenants)	1,447.0	1,200.0	1,320.6	1,247.8	-17.1	-8.7	-13.8
Farm managers	37.2	30.6	34.3	33.6	-17.9	-7.8	-9.9
Farm supervisors and laborers	1,205.0	962.8	1,071.5	1,046.1	-20.1	-11.1	-13.2
Farm supervisors	30.0	24.8	27.8	27.4	-17.4	-7.4	-8.7
Farm laborers	1,175.0	937.8	1,043.7	1,018.7	-20.2	-11.2	-13.3

[1] As a result of differences in definition or data sources, the 1980 and projected 1990 employment data differ from those presented in chapter II.

NOTE: n.e.c. = not elsewhere classified.
SOURCE: National industry/occupation matrix.

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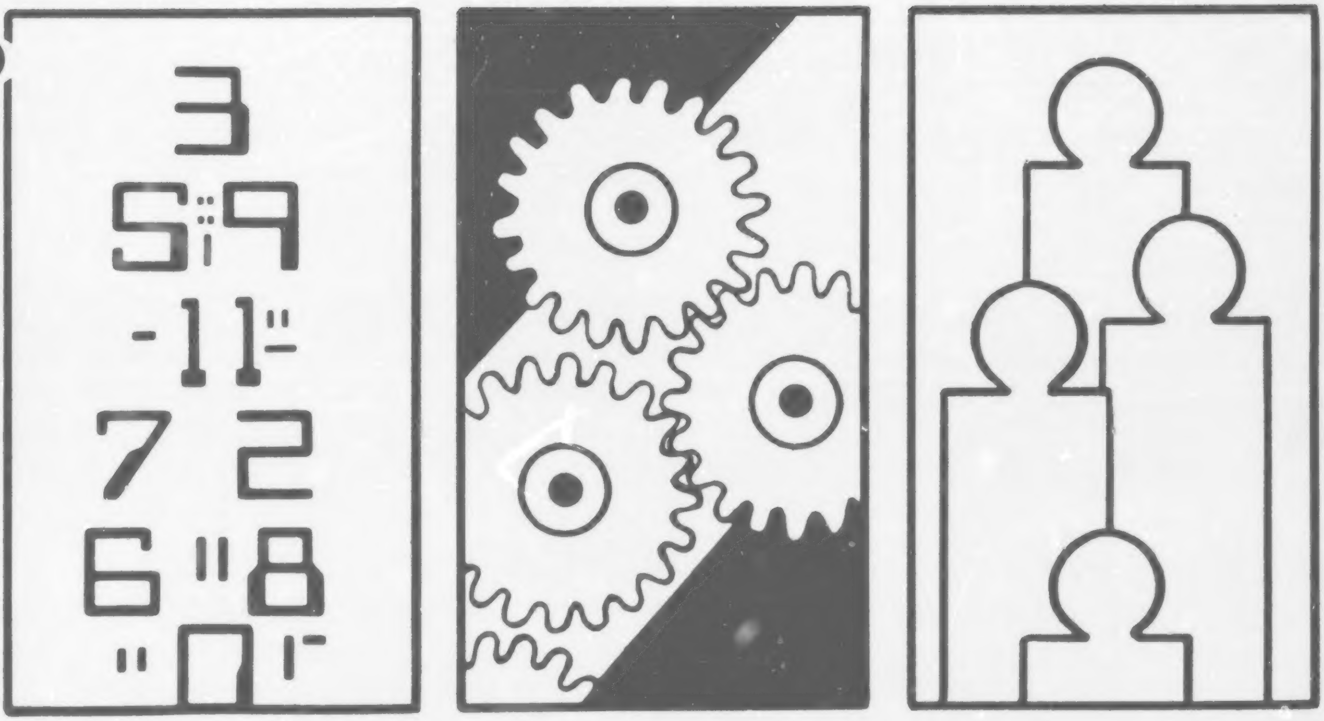
Apprenticeship Training Techniques



MODULE 4
PERFORMANCE-BASED APPRENTICESHIP TRAINING

REFERENCE MATERIALS

Performance-Based Apprenticeship Programs

The central feature of traditional time-based apprenticeship programs is the on-the-job training and experience received by the apprentice. This feature differentiates apprenticeship from other training or educational experiences and provides for a personalized, individualized method of transmitting skills when the program is operating well.

This personalized, individualized approach is incorporated explicitly in performance-based programs to ensure that the apprentice learns the skills required.

COMPONENTS OF PERFORMANCE-BASED PROGRAMS

Job Analysis

In performance-based programs the competencies that the apprentices should learn are determined in advance by a job or task analysis. This analysis focuses on the duties or tasks involved in performing the work. This is a critical part of developing performance-based training.

Performance Objectives

The competencies that must be learned are expressed in terms of student performance objectives--what the apprentice will be able to do upon successful completion of apprenticeship. Performance objectives have three components:

- Performance or behavior stated in measurable terms;
- A description of the conditions or limitations under which the apprentice is to perform; and
- A description of the acceptable performance standard or criterion.

Individualized Instruction

In performance-based programs, the instruction programs, tasks to be learned, and subjects to be studied are structured for each individual apprentice based on his/her background and skill level.

Related Instruction

The theory training--or related instruction--provided in performance-based programs focuses explicitly on what is required to do the job. The focus is on "need to know" rather than on "nice-to-know." Frequently theory training is self-paced and uses packaged learning materials including booklets, slide-tapes, or video tapes. These training materials may be divided into self-contained modules, each of which addresses a particular topic area

Feedback

Frequent feedback is provided to the apprentice in a performance-based program. The apprentice's progress is monitored closely in relation to the stated objectives to provide reinforcement and motivation in addition to diagnosing deficiencies so that remedial activities can be undertaken.

Flexible Learning Time

The time required by an apprentice to accomplish individual tasks and complete the overall program depends on the student's ability to complete the work. Apprentices are permitted to move ahead at their own pace, depending on their prior training, ability to master the task, and motivation to progress.

Criterion-Referenced Testing

A criterion-referenced test is designed to measure specific performance standards. The test measures if an apprentice can perform a task under controlled conditions. The testing usually focuses on manipulation of job-related equipment and materials rather than on paper and pencil tests, although these are also used in relation to the related instruction.

DEVELOPING A PERFORMANCE-BASED APPRENTICESHIP PROGRAM

Developing a performance-based apprenticeship program requires a considerable commitment of time, energy, and resources by a company.

The Sale

The major players involved in developing a program are the ATR, the training director at the company involved, and the senior managers or decisionmakers at the company.

The ATR needs to work to gain the support of both the training director and senior management about the desirability of developing a performance-based apprenticeship program. Senior management holds the purse strings and make final decisions. Support of the training director often is essential in convincing senior management and, of course, in undertaking the work involved to develop and carry out the program.

How should the ATR gain this support? First, The ATR must identify the critical personnel and plan the best approach for making the sale. The ATR must show that he or she understands the company's training requirements. The ATR also must explain the benefits and costs of the programs; and must offer them his or her support and assistance in developing the program.

None of these activities will bear fruit, however, unless the company is ready for a change--or unless the ATR can convince management that a change to performance-based training is desirable.

Why would a company want to switch to performance-based training? What characteristics might such a company have? A company generally should:

- Have a need for trained workers;
- Run a profitable, growing business; and
- Be unhappy with the quality of workers produced under its current program.

It is important to understand and to make management understand that development of a performance-based program is not a "quick fix" solution to a short-term problem. Short-term downturns in economic activity do not eliminate the need for trained workers tomorrow. Development of performance-based programs should be part of the company's long-term planning.

PROGRAM DEVELOPMENT

During program development, the company must undertake a series of tasks to develop the program. These include:

- Conduct a job analysis;
- Develop job performance objectives including job conditions and standards;
- Determine instructional techniques, materials, sequence, and testing techniques; and
- Develop or obtain materials for instruction and testing.

Job Analysis

In job analysis, the company (or union) specifies what is required to carry out a job. This is an absolutely critical part of developing performance-based apprenticeship programs. These tasks constitute the base-performance areas that an apprentice must learn. They include:

- Identify job functions;
- Identify tasks that make up each job function;
- Develop a job inventory sheet for each function with tasks; and
- Break down each task into steps involved in performing it and the tools, equipment, materials, and supplies needed to complete it.

Job Performance Objectives

These provide the standards, conditions, and behavior that apprentices will have to exhibit in carrying out a task.

Techniques and Materials

The techniques and materials to be used in the program can be developed in-house, purchased or borrowed from another source developed in conjunction with a local school or college, or a combination of the above. An impetus toward performance-based training in many organizations is unhappiness with the relevance of the related instruction provided by local schools or colleges. They react by bringing the instruction under their own control and by developing their own programs using their own instructors or by installing self-study materials. These courses or self-study units should then be tied in with the progression of the on-the-job training so that they complement and enhance each other. The testing program should relate the performance objectives specified. Testing should be criterion-referenced, i.e., it should measure if the students **behavior** meets the **standards** specified under the **conditions** established.

EXAMPLES OF PERFORMANCE OBJECTIVES

In the pages that follow are examples of performance standards or objectives from several different types of training programs.

Exhibit 4-1 shows standards taken from a traditional time-based program. These specify in broad terms the skills to be acquired and the approximate hours to be spent by the apprentice in learning the skills.

Exhibit 4-2 shows a set of performance objectives used in an apprenticeship program run by a major U.S. manufacturer. As you can see, these are much more specific than those included in Exhibit 4-2, but still do not describe the required performance in measurable terms, nor do they specify how the apprentice will be evaluated.

Exhibit 4-3, taken from the Job Corps carpentry program, provides a good example of performance-based objectives. They list what the student must learn, how the learning should be accomplished, and how well the learning should be mastered.

EXHIBIT 4-1

TRADITIONAL TIME-BASED APPRENTICESHIP STANDARDS
BRICKLAYER APPRENTICE

	Approximate Hours
a. Laying of masonry units	3,000
b. Laying of stone	450
(1) Cutting and setting of rubblework or stonework	
(2) Setting of cut-stone trimmings	
(3) Butting ashlar	
c. Pointing, cleaning, and caulking	150
(1) Pointing brick and stone, cutting and raking joints.	
(2) Cleaning stone, brick, and tile (water, acid, sandblast)	
(3) Caulking stone, brick, and glass block	
d. Installation of building units	525
(1) Tile cutting and setting	
(2) Cutting, setting, and pointing of special masonry units	
(3) Blockarching	
(4) Mixing mortar, cement, and patent mortar; spreading mortar; bonding and typing	
(5) Building footings and foundations	
(6) Plain exterior brickwork (straight wall work, backing up brickwork)	
(7) Building arches, groins, columns, piers, and corners	
(8) Planning and building chimneys, fireplaces and flues, and floors and stairs	
(9) Building masonry panels.	
e. Fireproofing	225
(1) Building party walls (partition tile, gypsum blocks, glazed tile)	
(2) Standardized firebrick	
(3) Specialities	
f. Care and use of tools and equipment	150
(1) Trowels	
(2) Brickhammer	
(3) Plumb rule	
(4) Scaffolds	
(5) Cutting saws	
(6) Welding equipment	
Total	4,599

EXHIBIT 4-2

PERFORMANCE STANDARDS FROM
APPRENTICE PROGRAM OF MAJOR U.S. COMPANY
ELECTRICIAN APPRENTICE

1. MAKE A HOT TAP (INCLUDING HOW TO GET SOMEONE OFF A HOT LINE)

2. BEND CONDUIT

3. INSTALL CONDUIT

    a. Rigid
    b. Liquid Tight Metal Conduit
    c. Flexible Metal Conduit
    d. EMT

4. MEASURE ELECTRICAL UNITS

    a. Vom Meter

        1) Measure Voltage
        2) Measure Resistance

    b. Amprobe

        1) Measure Amperage
        2) Measure Voltage

    c. Wiggins

        1) Measure Line Voltage From X Floor Main

    d. Test for Continuity with a Continuity Tester

5. GROUND ELECTRICAL APPARATUS

6. INSTALL LIGHTING CIRCUITS

    a. Hang Flourescent Fixtures
    b. Wire
    c. Install 110 VAC Wall Receptacles
    d. Install Single Pole Switches
    e. Install Two-Way Switches
    f. Install Four-Way Switches

7. INSTALL ELECTRICAL PROTECTIVE DEVICES

    a. Fuses
    b. Circuit Breakers
    c. Overload Relays
    d. Kov A-C Branch Circuit

EXHIBIT 4-2 (Continued)

8. INSTALL ELECTRONIC COMPONENTS

   a. Resistors
   b. Capacitors
   c. Transistors
   d. Tubes
   e. Rectifiers
   f. Photo-Electric Devices

9. INSTALL A-C CONTROL DEVICES

   a. Motor Starters
   b. Pushbutton Control Stations
   c. Limit Switches
   d. Special Control Switches
   e. Timers & Counters
   f. Control Relays
   g. Hazardous Location Equipment
   h. Special Motor Control
   i. Control Transformer
      1) Dual Voltage
      2) Variable Top

   j. Photo-Electric Units

10. INSTALL SINGLE PHASE MOTORS

    a. Split Phase Motors
    b. Capacitor
    c. Repulsion
    d. Universal

11. INSTALL THREE-PHASE MOTORS

    a. Induction
    b. Synchronous
    c. Multiple Speed - Dual Voltage
    d. Alternators
    e. Install Auxiliary Generator System
    f. Install Power Distribution System
    g. Install Buss Duct
    h. Connect 3-Phase MT - 1 HP
    i. Connect 3-Phase MT - 480 V Connection
    j. Connect 3-Phase MT - 240 V Connection

12. INSTALL D-C EQUIPMENT & CONTROLS

    a. Generator
    b. Relay
    c. Controller
    d. Power Supply

EXHIBIT 4-2 (Continued)

13. D-C MOTOR MAINTENANCE
    a. Undercut Commutator
    b. Turn Commutator
    c. Replace Brushes
    d. Adjust Brush Tension
    e. Clean Coils
    f. Replace & Lubricate Bearing

14. MAINTAIN POWER DISTRIBUTION SYSTEM

15. WIRE A CONTROL PANEL

16. MAINTAIN BATTERY CHARGERS

17. TROUBLESHOOT BATTERY CHARGERS

18. TROUBLESHOOT AND REPAIR D C SYSTEMS & EQUIPMENT

19. TROUBLESHOOT AND REPAIR A C SYSTEMS & EQUIPMENT

Carpentry
DOT 860

U.S. Department of Labor
Employment and Training Administration
Job Corps

INSTRUCTOR'S GUIDE

SUPPLEMENT A

- COMPETENCY LIST
- TASKS AND OBJECTIVES

Reference

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CARPENTRY COMPETENCY LIST

860

A. PREPARE FOR BUILDING TRADES

A1. Describe the Carpentry Trade
A2. Practice Safe Work Habits
A3. Practice First Aid Procedures

B. DEMONSTRATE BASIC HAND TOOL SKILLS

B1. Demonstrate Skill in Using Measuring Tools
B2. Demonstrate Skill in Using Testing Tools
B3. Demonstrate Skill in Using Marking Tools
B4. Demonstrate Skill in Using Tooth Cutting Tools
B5. Demonstrate Skill in Using Leveling and Plumbing Tools
B6. Demonstrate Skill in Using Smooth Cutting Tools
B7. Demonstrate Skill in Using Fastening Tools

C. DEMONSTRATE BASIC POWER TOOL SKILLS

C1. Demonstrate Skill in Using Portable Power Saws
C2. Demonstrate Skill in Using Portable Power Drills

D. PREPARE FOR CONCRETE WORK

D1. Establish Building Lines
D2. Erect Batterboards
D3. Construct and Place Footing Forms
D4. Construct and Erect Wooden Wall Forms
D5. Construct and Erect Column Forms
D6. Construct and Erect Spandrel Beam Forms

E. COMPLETE ROUGH FRAMING WORK

E1. Lay Out Plates and Rough Openings on Exterior Walls
E2. Measure and Cut Full Studs and Trimmers
E3. Cut and Fabricate Corner Posts, Headers and Rough Sills
E4. Assemble and Erect Exterior Wall Sections
E5. Lay Out, Assemble,and Erect Interior Partitions
E6. Plumb, Temporarily Brace, and Align Walls

F. SHEATHING AND CLADDING

F1. Install Sheathing Material
F2. Install Exterior Board Siding

G. COMPLETE FINISH WORK

G1. Apply Gypsum Wallboard
    a. Erect Gypsum wallboard
    b. Tape a Wallboard Joint

G2. Install Exterior Windows
G3. Install Door Frames
G4. Install Doors
G5. Install Door and Window Trim
G6. Install Interior Hardware

TASKS AND OBJECTIVES

CAG	TASK	CORPSMEMBER OBJECTIVE What You Need	What You Will Do	How Well
860 A1	Describe the Carpentry Trade	Information about duties, work conditions, and salaries of carpenters	Describe the carpentry trade	So that the Corpsmember scores 80 on a written test
860 A2	Practice Safe Work Habits	CAG 860 A2	Identify safe and unsafe working conditions	So that the Corpsmember achieves 100% on the Performance Test
860 A3	Practice First Aid Procedures	A partner to study with and first aid supplies	Learn basic first aid procedures for carpentry	So that the Corpsmember can correctly perform the criteria on the Performance Test
860 B1	Demonstrate Skill in Using Measuring Tools	A wooden zigzag folding ruler, a metal pocket tape, a 100' steel tape, a pencil, an 8' piece of 2"x4" lumber, and varied lengths of material	Measure, mark, and record lengths and distances	So that the finished product is within ± 1/16" of specifications
860 B2	Demonstrate Skill in Using Testing Tools	A combination square, a framing square, a pencil, and a 2x4	Draw 45° and 90° angled lines using a framing square and a combination square	So that the finished product is within ± 1/16" of the Performance Criteria specifications
860 B3	Demonstrate Skill in Using Marking Tools	A chalk box and scribers, a sheet of plywood, and some scribe of plywood	Snap lines and scribe curves and circles	To within ± 1/16" of the Performance Criteria specifications
860 B4	Demonstrate Skill in Using Tooth Cutting Tools	Tools, supplies, and information	Cut blocks of wood, and metal rods	So that the Corpsmember cuts to within ± 1/16" of the Working Drawing
860 B5	Demonstrate Skill in Using Leveling and Plumbing Tools	A framed practice wall, and appropriate tools	Level a cabinet. Level and plumb a wall. Transfer a line down	So that the Corpsmember is within ± 1/16" of the specifications of the instructor

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CAG	TASK	CORPSMEMBER OBJECTIVE What You Need	What You Will Do	How Well
860 B6	Demonstrate Skill in Using Smooth Cutting Tools	Smooth cutting tools and 2x4 wood block	Square measure, and cut a 2x4 block to receive 2 butt hinges	So that the finished cut is within ± 1/16" of the Working Drawing
860 B7	Demonstrate Skill in Using Fastening Tools	Hammers, nails, and wood stakes	Nail a variety of nails in a specific period of time	So that the Corpsmember places the required number of nails in the time allowed to within ± 1/16" of specifications and that the stakes are placed within ± 1/16" of specifications
860 C1	Demonstrate Skill in Using Portable Power Saws	A portable power saw	Cut 2x4 blocks and rip lengths of plywood	So that the cut is made within ± 1/16" of specifications
860 C2	Demonstrate Skill in Using Portable Power Drills	Portable power drill, wood and combination square	Drill horizontal and vertical holes in a block of 2x4	So that the finished product is within ± 1/16" of the Working Drawing
860 D1	Establish Building Lines	Basic carpentry tools, dry lines, and wooden stakes	Lay out building lines	So that they pass visual inspection by industry standards (to within ½ inch of the given plan).
860 D2	Erect Batterboards	Information, tools, and materials to erect batterboards	Cut material, locate and erect batterboards	So that batterboards resist movement and are placed in the exact location to within ± 1/16" of specifications
860 D3	Construct and Place Footing Forms	Information, tools, and materials to construct footing forms	Lay out, mark, cut, and construct footing forms	So that the footing forms pass visual inspection and meet the Working Drawing criteria to within ± 1/16" of specifications

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CAG	TASK	CORPSMEMBER OBJECTIVE What You Need	What You Will Do	How Well
860 D4	Construct and Erect Wooden Wall Forms	Tools and materials to construct wooden wall forms	Construct and erect wooden wall forms	So that they meet the specifications of the Working Drawing to within ± 1/16"
860 D5	Construct and Erect Column Forms	Basic carpentry tools, form plywood, 2x4 material, column clamp and fasteners	Lay out, construct, erect and brace the column form	So that the finished product is within 1/8" of the dimension on the Working Drawing and the column is square and plumb
860 D6	Construct and Erect Spandrel Beam Forms	Basic carpentry tools, form plywood, 2x4 material, 1x4 material, gussett plywood and fasteners	Lay out, construct, erect, brace and align a spandrel beam form	So that the finished product is within ± 1/8" of the dimension on the Working Drawing and the beam is straight and sturdy
860 E1	Lay Out Plates and Rough Openings on Exterior Walls	2x4 plates, and basic carpentry hand tools	Lay out rough openings and stud locations on top and bottom plates	So that your plate marks are within ± 1/8 inch of specifications
860 E3	Cut and Fabricate Corner Posts, Headers and Rough Sills	Framing material, basic carpentry tools	Fabricate cornerposts, headers, and rough sills	So that the finished dimensions are within ± 1/8 inch
860 E4	Assemble and Erect Exterior Wall Sections	Layed-out plates, fabricated headers, fabricated cornerposts, studs, trimmers, rough sills, and basic carpentry tools	Assemble and erect exterior wall sections for framing material	So that the finished product is within ± ½" in relation to the specified dimensions and the wall is straight and plumb
860 E5	Lay Out, Assemble, and Erect Interior Partitions	Basic carpentry tools and a supply of 2x4's	Lay out, assemble, and erect interior partitions	So that the finished product is within ± ½ inch of the dimensions on the Working Drawing and the walls are straight and plumb

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CAG	TASK	CORPSMEMBER OBJECTIVE What You Need	What You Will Do	How Well
860 E6	Plumb, Temporarily Brace, and Align Walls	Basic carpentry tools and bracing material	Plumb, brace and align walls	So that the finished product is within ± ¼" of the directions on the Working Drawing, and so that the walls are straight and plumb.
860 F1	Install Sheathing Material	Basic carpentry tools and sheathing materials	Lay out and install sheathing	So that the finished product is within ± 1/8" of the Working Drawing
860 F2	Install Exterior Board Siding	Basic carpentry tools, siding materials (including metal corner covers), and a sheathed wall	Lay out, align, and install various types of siding materials	So that the finished product is within ± 1/8" of the Working Drawing
860 G1	Apply Gypsum Wallboard	Drywall hand tools, wallboard, and joint compound	Measure, cut and hang wallboard, and cover drywall joints	So that cuts and installation are within ± 1/8" of directions and nails are placed according to directions, and so that the finished product is smooth and blends into the wall (or ceiling)
860 G2	Install Exterior Windows	Carpentry tools and exterior window	Install an exterior window	So that the window is plumb level and operates properly
860 G3	Install Door Frames	A door frame and carpentry tools	Install a door frame	So that the finished product is within ± 1/16 inch of the directions and the frame is plumb level
860 G4	Install Doors	A door and carpenter's tools	Install (hang) a door	So that the finished product is within ± 1/8" of the directions and so that the door opens and closes easily

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		CORPSMEMBER OBJECTIVE		
CAG	TASK	What You Need	What You Will Do	How Well
860 G5	Install Door and Window Trim	Basic carpentry tools and casing material	Make and install door and window trim and casing	So that the finished product is within ± 1/8" of the directions, and so that the molding is level and plumb
860 G6	Install Interior Hardware	Carpenter's tools and locksets	Install hardware	So that the finished product is within ± 1/8" of the directions

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Curriculum Resources

There has been a recent surge of interest throughout the country in curriculum and instructional materials development. Many guides, course outlines, and other instructional materials have been and are in the process of being developed. The resources in this section have been collected from many sources, including professional organizations, state education departments, federal agencies, schools, curriculum clearinghouses, research organizations, the commercial market, and universities and colleges.

What follows are descriptions of a variety of printed instructional materials, including curriculum guides, course outlines, learning activity packages, task analyses, occupational inventories, student manuals, performance objectives, and tests. The materials can be obtained by writing to the publishers whose addresses appear with each listing.

Some documents are available through the Educational Resources Information Center (ERIC), while others are available from The Vocational Education Center at the Ohio State University.

AIDS TO PERFORMANCE-BASED PROGRAM DEVELOPMENT

Civil Service Examination Passbooks. National Learning Corp., 212 Michael Dr., Syosset, New York 1179.

National Learning has published study guides that contain hundreds of multiple-choice questions and answers. Most levels of different occupations are covered, including several in graphic arts. Write National Learning for a catalog of the specific examination booklets available.

Competency-Based Vocational Teacher Modules. Wayne State University, College of Education, Detroit, Michigan 48202, 1975, Five Booklets.

These five booklets or modules are aimed at providing vocational teachers with the skills to develop and use a performance-based instructional program. The modules cover program goals, performance objectives, objective-referenced testing, selecting learning activities and evaluation. Slidetape presentations and transparencies are also available which augment the booklets. The books may be purchased separately.

Competency-Based Vocational Education Series. Division of Vocational-Technical Education (DVTE), Maryland State Department of Education, The Maryland Vocational Curriculum Production Project, Western Maryland

Vocational Resource Center, P.O. Box 5448, McMullen Highway, Cresaptown, Maryland 21502, 1978, Nine Booklets.

This series of nine booklets is designed to help vocational educators implement performance-based vocational education. The following booklets are in the series:

What is Competency-Based Vocational Education (CBVE)?
How to Do a Job Analysis
How to Write a Course of Study
How to Write and Use Competency Profiles
How to Write Performance Objectives
How to Individualize Instruction
How to Write and Use Student Competency Sheets
How to Write and Use Learning Activity Packages
How to Evaluate Students in a CBVE Program

Designing Essay, Objective, and Performance Tests. Vocational Instructional Services, Texas A & M University, F. E. Box 182, College Station, Texas 7784.

This book contains information about testing student achievement in vocational education. Examples of tests covering a variety of trade areas are included. This resource can be used to prepare both standardized and informal teacher-made tests.

Designs for Individualization. Westinghouse Learning Corp., 100 Park Avenue, New York, New York 10017.

Westinghouse has developed this kit which can be used in preservice and inservice programs to train teachers on how to individualize instruction. Such topics as writing objectives, the role of the teacher and student in the individualized classroom, and implementation strategies are covered. The kit contains three sound filmstrips, an administrator's handbook, and teacher workbooks.

Development of Learning Objectives. National Laboratory for the Advancement of Education, The Aerospace Education Foundation, 1750 Pennsylvania Avenue, N.W., Washington, D.C. 20006, 1976.

This course is designed to train individuals to write learning objectives. Units cover technical training design, course control, principles of learning objectives, criterion-referenced testing, and planning instruction. The course is similar to other courses designed by the National Laboratory for the Advancement of Education.

Development and Management of Instructional Systems. National Laboratory for the Advancement of Education, The Aerospace Education Foundation, 1750 Pennsylvania Avenue, N.W., Washington, D.C. 20006, 1976.

Created and validated by the U.S. Air Force, this instructional program contains texts, workbooks, lesson plans, and programmed units dealing with instructional systems. A complete plan of instruction spells out sequentially the objectives for each module in the system, including support materials and instructional methodology. This course is designed to provide training to managers, supervisors, and educators in current concepts of instructional systems.

Directory of Task Inventories. The Center for Vocational Education, The Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210, Volume 1, 1974.

A compiled listing of available task inventories/analysis, these books are of value to curriculum developers, training directors, personnel officers, vocational teachers, and administrators. The information in these volumes is based on a review of documents from state, educational, and employment service agencies, curriculum laboratories, research coordinating units, the armed forces, private agencies, and other organizations. Over 350 DOT job titles are covered in these comprehensive references.

Employability Profiles Manual. Nassau County DOCES, Division of Occupational Education, 1196 Prospect Avenue, Westbury, New York 11590, 1973.

This manual contains employability profiles for most vocational education areas. Each profile contains a skills listing and a section on attitudes, behaviors and work traits. The form covering masonry is a good idea for record keeping and evaluative purposes.

Handbook of Performance Testing: A Practical Guide for Test Makers, by J. L. Boyd, Jr. and B. Shimberg. Educational Testing Service, Princeton, New Jersey 08540, 1971, 182 pp., available from ERIC (ED 052 220).

Intended for the classroom teacher, this handbook is an excellent source for instructors who would like to develop and use performance or skill testing. Examples, case studies, and practical guidelines are given to aid the teacher in developing tests. Examples of performance tests are included.

How to Write an Instructional Package. EDU-PAC of Minnesota, P. O. Box 27101, Minneapolis, Minnesota, 1975.

This learning activity package is designed to show how to develop and write a self-instructional package for any subject area.

Instructional Development Learning System. Educational Systems for the Future, 10451 Twin Rivers Road, Columbia, Maryland 21044, 1975.

Educational Systems for the Future has designed this self-paced learning system to teach educators how to design self-instructional programs. Workbooks and slide-tape presentations cover task analysis, criterion test items, learning hierarchies, instructional strategies, instructional media, and instructional materials. Slide-tape presentations and workbooks may be purchased individually.

Manufacturing and Related Fields. Instructional Materials Laboratory, 1976. Trade and Industrial Education, The Ohio State University, 1185 Neil Avenue, Columbus, Ohio 43210.

The purpose of this manual is to provide vocational education instructors with a resource that explains how task survey techniques can be used in developing and maintaining a valid vocational curriculum in manufacturing and related fields. The material in this guide is divided into five sections: the development of task listings; acquisition of survey data and statistical treatment; a strategy for task analysis; the development of performance objectives; and developing a scope and sequence of instruction. Task listings are included for the areas of machine shop, drafting, welding, and electric motor repair. The appendices contain samples of cover letters, instruction sheets, information sheets, and a bibliography.

Performance Objectives Development Project. Michigan Department of Education, Vocational-Technical Education Service, P. O. Box 928, Lansing, Michigan 48904, 1974.

Michigan has developed several sets of performance objectives dealing with the electrical and electronics occupations. The objectives cover such areas as electrical fundamentals, electrical construction wiring, appliance repair, and radio and television servicing. Over 100 sets of objectives covering other vocational areas have been developed as a result of the project.

Planning and Equipping School Shops for Trade and Industrial Education. Research and Curriculum Unit, Mississippi State University, Drawer DX, State College, Mississippi 39762, 1969.

This publication contains detailed floor plans for most vocational shops, including masonry.

Proceedings of a Symposium on Task Analysis/Task Inventories, by P. Schroeder. The Center for Vocational Education, The Ohio State University, 1960 Kenny Road Columbus, Ohio 43210, 1976.

Papers that were delivered at a symposium on task analyses/task inventories are contained in this book. Processes and techniques on how to conduct and use task analyses are described.

Standards and Formats for Vocational-Industrial Instructional Materials. Vocational Instructional Services, F. E. Box 182, Texas A & M University, College Station, Texas 77843.

This publication shows the relationship of various types of instructional sheets and aids, the origin of each, and how each contributes to the teaching of a complete lesson.

Student Competency Sheets. West Virginia Vocational Curriculum Laboratory, Cedar Lakes Conference Center, Ripley, West Virginia 25271, 1976.

These competency sheets were developed for use in a new vocational school, Boone County Center in West Virginia. Designed to promote individualized competency-based instruction, each sheet contains a performance objective, learning activities, and an evaluation section.

Task Analysis Inventories: A Method for Collecting Job Information. U.S. Department of Labor, Manpower Administration, 1973, 201 pp., available from the U. S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402.

The inventories in this publication were developed in accordance with the Handbook for Analyzing Jobs. Most of the inventories are general and should be supplemented with in-depth job studies.

Tests and Measurement. National Laboratory for the Advancement of Education, The Aerospace Education Foundation, 1750 Pennsylvania Avenue, N. W., Washington, D. C. 20006, 1976.

Created and validated by the U. S. Air Force, this self-paced program consists of texts, workbooks, lesson plans, and programmed units on designing tests and measurement devices. A complete plan of instruction spells out sequentially the learning objectives for each module in the system, including support materials and instructional methodology keyed to the objectives. This course includes units on: measurement concepts, objectives, and procedures; the use of course control documents; the preparation of objectives; the preparation of progress checks, criterion tests, and teaching steps; construction of measurement tests; uses and preparation of criterion checklists; and the procedure for administering and analyzing tests.

Vocational-Technical Education Consortium of States (V-TECS) Curriculum Project. Vocational-Technical Education Consortium of States, Southern Association of Colleges and Schools, 795 Peachtree Street, N.E., Atlanta, Georgia 30308.

An extensive and comprehensive curriculum project was carried out by member states of the Vocational-Technical Education Consortium of States (V-TECS). V-TECS was formed in 1973, with its fundamental purpose to develop catalogs of performance objectives, performance guides, and criterion-referenced measures. The Consortium developed objectives based upon a uniform procedure consisting of: (1) development of an occupational inventory of job titles; (2) selection of a representative random sample of incumbent workers; (3) administration of the inventory to incumbent workers; (4) computerized analysis of the information collected from the sample in terms of time spent on tasks, difficulty of tasks, etc.; (5) conversion of the task statements into performance objectives with companion criterion-referenced measures and performance guides; and (6) a comprehensive field review and dissemination program. Each state developed at least two occupational areas.

Audiovisual Methods. National Laboratory for the Advancement of Education, The Aerospace Education Foundation, 1750 Pennsylvania Avenue, N. W., Washington, D. C. 20006, 1976.

Developed by the U.S. Air Force, this instructional program contains texts, workbooks, lesson plans, and programmed units dealing with audiovisual materials. A complete plan of instruction spells out sequentially the learning objectives for each module in the system, including support materials and instructional methodology keyed to the objectives. This course gives the individual both training and practical experience in the selection, design, production, application, and validation of audiovisual software.

Applications of audiovisual media to specific learning situations are presented, as well as the introduction of production methods and techniques to all facets of audiovisual software design.

Basic Mathematics, Books I-III. Westinghouse Learning Corp., 100 Park Avenue, New York, New York 10017.

These books cover the basics in math. The first book covers an introduction to fractions. The second book emphasizes multiplying and dividing fractions. Decimals and basic geometry principles are covered in the last book.

Basic Mathematics, Instructor's Guide. Instructional Materials Laboratory, University of Missouri - Columbia, 8 Industrial Education Building, Columbia, Missouri 65201, 1971.

This instructional guide includes materials on the concepts of number theory, whole number operations, fractions, decimals and applied geometry, as well as computational practice related to practical applications.

Basic Vocational Mathematics - Part I. Vocational-Technical Curriculum Laboratory, Rutgers University, Building 4101, Kilmer Campus, New Brunswick, New Jersey 08903, 1971.

This publication offers a thorough review of the fundamentals of arithmetic. Units cover fundamental arithmetic, fractions, the ruler, decimals, and percentages. Actual descriptions of twenty different trades are included in the text, and word problems are oriented to several trade areas.

Basic Vocational Mathematics - Part II. Vocational-Technical Curriculum Laboratory, Rutgers University, Building 4103, Kilmer Campus, New Brunswick, New Jersey 08903, 1971.

After a thorough review of the fundamentals of arithmetic covered in Part I, this book continues on to new concepts. The book includes units on common business transactions, money and checks, equations, ratios and proportions, angular measurements, and formulas. Additional word problems are included.

Cooperative Industrial Education - Safety Manual. Vocational-Technical Curriculum Laboratory, Rutgers University, Building 4103, Kilmer Campus, New Brunswick, New Jersey 08903, 1976.

This manual deals with safety practices in a multitude of diversified occupations. Topics covered include: rules and regulations; general and specific safety tests; safety instruction; safety checklists; OSHA rules and regulations; safety equipment, maintenance, and preventive maintenance.

Glossary of Key Words. Vocational-Technical Curriculum Laboratory, Rutgers University, Building 4103, Kilmer Campus, New Brunswick, New Jersey 08903, 1977.

This series of 32 glossaries contains the most important terms used in a particular trade. Each word is divided into syllables, and defined in two definitions--one general and one technical. Some of the trades covered by the glossaries include: appliance repair; drafting; auto body; auto mechanics; building trades; cosmetology; diesel power; industrial electricity and electronics; machine shop; radio/television repair; and welding.

Hands-on Metrics. Mafex Media Aids, 90 Cherry Street, Johnstown, Pennsylvania 15902.

This packet of materials covers the basics of metrics. Metric activities for the classroom, a self-test, and metric conversion tables are included.

How to Read, Use, and Care for Micrometers and Vernier Gages--English and Metric Graduations. L. S. Starrett Co., Athol, Massachusetts 01331, 1975.

Math, Blueprint Reading, and Measuring Tools. Oklahoma Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1515 West Sixth Avenue, Stillwater, Oklahoma 74074, 1975.

This is a student workbook developed for teaching the basic principles of math, blueprint reading, and measuring tools.

Mathematics for Employment. L. Parsky, Mafex Associated, Inc., 111 Barron Avenue, Johnstown, Pennsylvania 15906, 1970.

This publication is available in two parts. Both cover basic arithmetic skills (+, -, x, ÷). Student worksheets include basic problems with no carrying through word problems. An emphasis is placed on practical applications, i.e., incorporation of forms commonly used in restaurants, retail outlets, laundry, cleaners, etc. Pages are perforated.

Metrication. American Society for Metals, Education Department, Metals Park, Ohio 44073, 1976.

This source contains sections on the experiences of other countries in the metrication process, the metric system, conversion problems in standards, product design, production, maintenance of metric inventories, and worker reeducation. An appendix of charts and conversion aids is included.

Metric Conversion Data. L. S. Starrett Company, Athol, Massachusetts 01331, 1975.

This pamphlet outlines the history of the metric system. It compares measuring tools graduated in English and metric units. How to read the metric outside micrometer and vernier gages is explained. Conversion tables cover: shop fractions to decimals to millimeters; metric to English; English to metric, and degrees Fahrenheit to degrees Celsius.

Metric Education: An Annotated Bibliography for Vocational, Technical, and Adult Education. The Center for Vocational Education, The Ohio State University, 1960 Kenney Road, Columbus, Ohio 43210, 1975.

Over 350 metric instructional and reference materials are listed in this publication. Information about content, instructional strategies, educational level, and price is included for each.

Metric Guide for Educational Materials. American National Metric Council, 1625 Massachusetts Avenue, N. W., Washington, D. C. 20036.

This guide's purpose is to aid in the consistent use of the metric system. The guide includes accepted metric practice for units and symbols, prefixes, numerals, and compound units. A comprehensive chart that provides guidelines for the use of nonmetric units is also included.

Metric Resource Listing. Curriculum Development Center, Taylor Education Building, Room 151, University of Kentucky, Lexington, Kentucky 40506, 1974.

This resource listing compiled by Kentucky includes books, films, transparencies, and individualized materials pertaining to the metric system.

Metrics. Instructional Materials Laboratory, University of Missouri-Columbia, 8 Industrial Education Building, Columbia, Missouri 65201.

This is a basic instructional kit for teaching metrics. The kit includes six sets of transparency masters covering the following areas: introduction to metrics; linear; linear to square; square to cubic to volume; volume to mass; luminous intensity; electric current; temperature; amount; and time. Each set include basic subject matter, numerous worksheets, and student exercises.

Metric System. National Book Company, Educational Research Assocciation, 1019 S. W. Tenth Avenue, Portland, Oregon 97205.

This individualized program is designed to teach the basics of the metric system at the primary and secondary levels. The cassette is correlated with the syllabus and moves the student step-by-step through each part in a logical manner.

Metrication Reference Manual, by H. L. Riess. TAD Products, Corporation, 639 Massachusetts Avenue.

This loose-leaf book contains general information about metrication, in addition to instructions on how to convert to the system.

Micrometers, Calipers, and Gages. Instructional Materials Laboratory, University of Missouri - Columbia, 8 Industrial Education Building, Columbia, Missouri 65201.

This manual contains a complete explanation of the use of different types of measuring devices, including micrometers, vernier calipers, thickness gauges, and wire gauges. Five tear-out worksheets are part of the manual. Overhead transparencies are available to complement the manual's content.

Safety. Vocational Education Media Center, Clemson University, 109 Freemen Hall, Clemson, South Carolina 29631, 1968.

This guide has been prepared to aid teachers in conducting an effective program of safety instruction. The text contains general information on safety responsibilities, first aid, teacher liability, specific shop and lab rules, a transparency list, and other related information.

Safety Instructional Materials. Hobar Enterprises, Hobar Publications, 1305 Tiller Lane, St. Paul, Minnesota 55112.

Safety and operation information about 24 woodworking and metalworking power tools are contained in this student manual. The instructor's packet includes one student manual, suggested student/teacher activities, safety exams, 24 transparency masters, and other related materials.

Safety: Interpretation of OSHA for Industrial Education. American Council of Industrial Arts Supervisors, Capitol Complex, Building D., Room B-318, Charleston, West Virginia 25305.

This monograph conveys the safety regulations that must be followed by industrial education teachers in order to be in compliance with the

Occupational Safety and Health Act (OSHA). General safety, labeling standards, color coding, and occupational safety and health standards are covered.

Vocational Related Math for Vocational Improvement Programs - Touchdown. Vocational Curriculum Laboratory, Tennessee, Department of Education, P. O. Box 1114, Murfreesboro, Tennessee 37130, 1972.

The material in this book is intended for use by instructors and students in vocational-related courses. Each section contains information sheets, suggested supplementary materials, skill practice sheets, assignment sheets, and evaluation sheets. The topics covered include measurements, fractions, percent, and whole numbers.

VOCATIONAL EDUCATION BIBLIOGRAPHIES

Individualization and Modularization of Vocational Education Instructional Materials: An Annotated Bibliography of Publications and Projects, by J. H. Magisos and A. E. Stakelon. The Center for Vocational Education, The Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210, 1975.

This bibliographical publication lists documents, journal articles, and current projects related to the individualization and modularization of vocational education instructional materials. Most documents listed are available in microfiche or paper copy from the ERIC Document Reproduction Service or the original source.

National Annotated Bibliography of Curriculum Materials in Vocational and Career Education. East Central Curriculum Management Center, Professional and Curriculum Development Unit, Division of Vocational-Technical Education, 100 North First Steet, Springfield, Illinois 62777, 1974.

This bibliography is the result of a nationwide search for instructional materials in the areas of occupational and career education. Most of the annotations cover state curriculum guides and contain descriptions of the material, prices, and a listing of where copies can be obtained. This is a good source of information for teachers, curriculum specialists, and administrators, but some of the materials are out-of-date or hard to obtain.

Programmed Learning and Individually Paced Instruction Bibliography, by C. H. Hendershot. Programmed Learning, 4114 Ridgewood Drive, Bay City, Michigan 49706, 1975.

Included in this loose-leaf bibliography are descriptions of programmed instructional materials in vocational areas, including masonry.

Research and Development Projects in Vocational Education and U.S. Office of Education Curriculum Development Projects. U.S. Office of Education, Division of Occupational and Adult Education, 400 Maryland Avenue, S.W., Washington, D. C. 20202.

These two listings are issued each fiscal year by the U.S. Office of Education. They indicate the research and development projects and curriculum projects that have been funded by USOE for the current year. Especially valuable to those involved in research and curriculum development.

Research in Industrial Education: Retrieval of Data from Information Systems, by D. L. Jelden. American Industrial Arts Association, 1201 16th Street, N.W., Washington, D.C. 20036.

This monograph offers brief explanations of some of the prominent data systems and information resources from which vocational-technical educators can obtain information. It is written for the classroom teacher who wants to find information in a quick and effective way. Such systems as DATRIX, the National Technical Information Service, and the Educational Resources Information Center (ERIC) are discussed.

Resources in Vocational Education (Formerly called Abstracts of Instructional and Research Materials in Vocational and Technical Eduation). The Center for Vocational Education, The Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210.

Resources in Vocational Education is a bimonthly publication that contains annotations of research and instructional materials dealing with vocational education. Formerly called AIM/ARM, this resource now uses ERIC ED numbers instead of VT numbers. Resources in Vocational Education contains all the vocational-technical materials which are announced in the ERIC journal, Resources in Education (RIE). A section on projects in progress is also included. This publication is a valuable resource for finding out what is going on in the curriculum development and research fields.

Trade and Industrial Education Resource Materials, by R. Lambert, F. Holman, and B. Ross-Thomson. The Center for Studies in Vocational and Technical Education, Educational Building, Box 49, Madison, Wisconsin 53706, 1975.

A comprehensive bibliography of non-commercial resource materials, this booklet lists study guides, reference materials, teaching aids, course outlines, learning activity packages, and curriculum materials. Although intended to be used as a listing of materials for a free loan system in Wisconsin, the bibliography is a good reference since it contains resources which are available nationwide.

Vocational Education State Instructional Materials for Trade and Industrial Occupations. Oklahoma Curriculum and Instructional Materials Center, 1974.

This annotated listing indicates available curriculum materials from various state education agencies. This booklet is a good source of information, but some materials are out-of-print or hard to obtain.

Vocational-Technical Learning Materials, by D. Reinhart. Bro-Dart Publishing Company, 1609 Memorial Avenue, Williamsport, Pennsylvania 17701, 1974.

> There are over 5,000 books and journals briefly annotated in this comprehensive listing. Prices and grade levels are indicated. A rating system is used to show which sources should be acquired first. Sources are critically annotated, indicating strengths and weaknesses of each entry.

CURRICULUM DEVELOPMENT CENTERS

The following is a list of instructional materials centers or laboratories, curriculum labs, and research and development centers. Each agency offers a variety of curriculum materials such as curriculum guides, learning activity packages, transparencies, and tests. Most of the materials are competency-based, self-paced, and adaptable for individualized instruction. One should write directly to an organization for their catalog.

California State Department
of Education
721 Capitol Mall
Sacramento, California 95814

Curriculum Materials Service
Department of Vocational Education
Colorado State University
Vocational Education Building
Fort Collins, Colorado 80523

Career Education Center
415 North Monroe Street
Tallahassee, Florida 32306

American Association for
Vocational Instructional Materials
Engineering Center
Athens, Georgia 30602
The Center for Vocational Education
Curriculum Materials Development
628 Aderhold Hall
University of Georgia
Athens, Georgia 30602

Vocational Curriculum Development
and Research Center
P. O. Box 657
Natchitoches, Louisiana 71457

Illinois Curriculum Management
Center
Division of Vocational and
Technical Education
1035 Outer Park Drive, Suite 201
Springfield, Illinois 62706

Indiana Curriculum Materials
Center
T. A. W. 108
Indiana State University
Terre Haute, Indiana 47803

Iowa Association for Vocational
Instructional Materials
Agricultural Engineering Department
Iowa State University
Engineering Center

Kansas Vocational and Technical
Curriculum Center
Kansas State College of Pittsburgh
Pittsburgh, Kansas 22762

Curriculum Development Center
Taylor Education Building, Room 151
University of Kentucky
Lexington, Kentucky 40506

Vocational Curriculum Research &
Development Center
Department of Industrial Education
University of Maryland
College Park, Maryland 20742

Technical Education Research Center
44 Brattle Street
Cambridge, Massachusetts 02138

Massachusetts Center for
Occupational Education
Two Sun Life Park, 100 Worcester St.
Wellesley Hills, Massachusetts 02181

Minnesota Instructional Materials
Center
3300 Century Avenue North
White Bear Lake, Minnesota 55110

Research and Curriculum
Coordinating Unit
Mississippi State University
P. O. Drawer DX
State College, Mississippi 39762

Instructional Materials Laboratory
8 Industrial Ed., University of
Missouri
Columbia, Missouri 65201

Vocational-Technical Curriculum
Rutgers University
Building 4103 - Kilmer Campus
New Brunswick, New Jersey 08903

Vocational Instruction Unit
New Mexico State Department of
Education
Education Building
Sante Fe, New Mexico 87503

Institute for Occupational Educat
Cornell University
Stone Hall
Ithaca, New York 14840

The National Center for Research
Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210 Department

Instructional Materials Laboratory
Trade and Industrial Education
The Ohio State University
1885 Neil Avenue, Room 112
Columbus, Ohio 43210

Curriculum and Instructional
Materials Center
State Department of Vocational and
Technical Education
1515 West Sixth Avenue
Stillwater, Oklahoma 74074

Continuing Education Publications
Extension Annex
Corvallis, Oregon 97331

Vocational Education Resource
Regional Office of Education
Box 729
Hato Rey, Puerto Rico 00917

Vocational Education Media Center
Clemson University
Freemen Hall
Clemson, South Carolina 29631

Vocational Instructional Services
Vocational-Industrial Education
Department
Texas A & M University
College Station, Texas 77843

Vocational Curriculum Laboratory
State of Tennessee
Department of Education
P. O. Box 1114
Murfreesboro, Tennessee 37130

Instructional Materials Center
Division of Extension
The University of Texas at
Austin
Austin, Texas 78712

The Center for Occupational Educa
North Carolina State University
Raleigh, North Carolina 27607

Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271

Mid-American Vocational Curriculum
Consortium
1515 West Sixth Avenue
Stillwater, Oklahoma 74074

Wisconsin Vocational Studies Ctr.
321 Education Building
University of Wisconsin - Madison
Madison, Wisconsin 53706

EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

The Educational Resources Information Center (ERIC) of the National Institute of Education has established a national network of clearinghouses which are designed to provide educators access to research reports and other non-commercial literature.

The ERIC Clearinghouses have the responsibility within the network for acquiring the significant educational literature within their particular areas, selecting the highest quality and most relevant material, processing (i.e., cataloging, indexing, abstracting) the selected items for input to the data base, and providing information analysis products and various user services based on the data base. Documents within ERIC can be obtained in microfiche (film) or hard copy (paper).

ERIC announces the documents processed by its clearinghouses through two publications: Resources in Education (RIE) for research reports and other documents, and the Current Index to Journals in Education (CIJE) for articles from over 700 journals.

Currently, the Clearinghouse for Adult, Career, and Vocational Education is located at The Ohio State University. Bibliographies, technical reports, and computer searches are available. They also produce a specialized version of RIE entitled Resources in Vocational Education (RIVE). For details write to Ohio State.

ERIC NETWORK COMPONENTS

There are currently sixteen (16) ERIC Clearinghouses, each responsible for a major area of the field of education. Clearinghouses acquire, select, catalog, abstract, and index the documents announced in Resources in Education (RIE). They also prepare interpretive summaries and annotated bibliographies dealing with high interest topics and based on the documents analyzed for RIE. These information analysis products are also announced in Resources in Education.

Adult, Career, and Vocational Education (CE)
Ohio State University
1960 Kenny Road
Columbus, Ohio 43210

Counseling and Personnel Services (CG)
University of Michigan
School of Education Building, Room 2108
East University & South University Sts.
Ann Arbor, Michigan 48104

Early Childhood Education (PS)
University of Illinois
805 West Pennsylvania Avenue
Urbana, Illinois 61801

Educational Management (EA)
University of Oregon
Eugene, Oregon 97403

Handicapped and Gifted Children (EC)
Council for Exceptional Children
1920 Association Drive
Reston, Virginia 22091

Higher Education (HE)
George Washington University
One Dupont Circle, N. W., Suite 630
Washington, D.C. 20036

Information Resources (IR)
Area Instructional Technology
School of Education
Syracuse University
Syracuse, New York 13210

Tests, Measurement, and Evaluation (TM)
Educational Testing Service
Princeton, New Jersey 08540

Reading and Communication Skills (CS)
National Council of Teachers
111 Kenyon Road
Urbana, Illinois 61801

Junior Colleges (JC)
University of California at Los Angeles
Powell Library, Room 96
405 Hilgard Avenue
Los Angeles, California 90024

Languages and Linguistics (FL)
Center for Applied Linguistics
1611 North Kent Street
Arlington, Virginia 22209

Rural Education and Small Schools (RC)
New Mexico State University
Box 3 AP
Las Cruces, New Mexico 88003

Science, Mathematics, and Environmental Education (SE)
1200 Chambers Road
Third Floor
Columbus, Ohio 43212

Social Studies/Social Science Education (SO)
Social Science Education Consortium, Inc.
855 Broadway
Boulder, Colorado 80302

Teacher Education (SP)
American Association of Colleges for Teacher Education
One Dupont Circle, N.W., Suite 616
Washington, D. C. 20036

Urban Education (UD)
Teachers College
Columbia University
Box 40
New York, New York 10027

Educational Resources Information
  Center (Center ERIC)
National Institute of Education
Washington, D. C. 20208
Telephone: (202) 254-5555

ERIC Document Reproduction Service
P. O. Box 190
Arlington, Virginia 22210
Telephone (703) 841-1212

ERIC Processing & Reference Facility
4833 Rugby Avenue, Suite 303
Bethesda, Maryland 20014
Telephone: (301) 656-9723

MacMillan Information
866 Third Avenue
New York, New York 10022
Telephone: (212) 935-4300

THE NATIONAL NETWORK FOR CURRICULUM COORDINATION IN VOCATIONAL AND TECHNICAL EDUCATION (NNCCVTE)

A nationwide curriculum management system has been established by the U.S. Office of Education for the purpose of providing a controlled system through which vocational and technical education curriculum materials can be shared and duplication of efforts avoided.

California, Illinois, Kentucky, Mississippi, New Jersey, Oklahoma, and Washington are serving as curriculum coordinating centers. Each of these states houses a curriculum management center designed to provide services to educators within their region concerning curriculum and instructional materials. These services include national and state articulation and coordination of available materials, dissemination and diffusion of selected materials, plus acquisition and display of materials in a professional resource library.

Each regional center holds meetings with its state liaison personnel to identify and discuss curriculum activities and materials at both the state and national levels, and to collectively pool anticipated needs. Regional and national newsletters are also published.

Northeast Curriculum Coordination
  Center
Bureau of Occupational Research
Division of Vocational Education
225 West State Street
Trenton, New Jersey 08625

Midwest Curriculum Coordination
  Center
Oklahoma State Department of
  Vocational & Technical Education
1515 West 6th Avenue
Stillwater, Oklahoma 74074

Southeast Curriculum Coordination
  Center
Mississippi State University
Research and Curriculum Unit
Drawer JW
Mississippi State, Mississippi 39762

Northwestern Curriculum
  Coordination Center
Washington State Coordinating
  Council for Occupational
  Education
222 Air Industrial Park/Box 17
Olympia, Washington 98504

East Central Network for Curriculum
Illinois Office of Education
100 North First Street (E-426)
Springfield, Illinois 62777

Western Curriculum Coordination
Center
University of Hawaii
College of Education, Wist Hall 216
1776 University Avenue
Honolulu, Hawaii 96822

Bibliography

Blank, William E. Handbook for Developing Competency-Based Training Programs, Englewood Cliffs, N.J.: Prentice Hall, 1982.

Foster, Phillip R. and Fowler, David S., eds. Common Core of Materials for Implementing Competency-Based Vocational Education, College Park, Md., Maryland Vocational Curriculum Research and Development Center, 1979.

Illinois State Board of Education. Specifications and Model Format for the Curriculum Products in Vocational Education, Springfield, Illinois.

International Union of Operating Engineers, Training Standards Project, A Task Analysis of Selected Operating Engineers, Washington, D.C., 1983.

Mager, Robert F. Goal Analysis, Belmont, Calif.: Fearon Publishers, Inc., 1972.

Mager, R. F. and Beach Jr., K. M. Developing Vocational Instruction, Belmont, Calif.: Fearon Publishers, Inc., 1967.

Mager, Robert F. and Pipe, P. Analyzing Performance Problems, Belmont, Calif.: Fearon Publishers, 1970.

The National Center for Research in Vocational Education, Basic Facts About DACUM, the Ohio State University, 1960 Kenny Road, Columbus, Ohio 43210.

MODULE 4
PERFORMANCE-BASED APPRENTICESHIP TRAINING

EXERCISE MATERIALS

Exercise
Apprenticeship Program Criteria

LIST 1: INDIVIDUAL LISTING

Working alone, list all criteria you can think of that contribute to successful apprenticeship programs.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________
18. ____________________
19. ____________________
20. ____________________

LIST 2: SMALL GROUP CONSENSUS LIST

Working with your small group, develop a listing that reflects your group consensus about the most important criteria for successful apprenticeship programs. List only ten elements in their order of importance. Appoint a member of your group to act as recorder/reporter.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

LIST 3: WHOLE GROUP CONSENSUS

If you wish, copy here the list of criteria that represent the group consensus on elements important to successful apprenticeship.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________

Berg Electronics

Berg Electronics is a subsidiary of DuPont. The firm makes molded and stamped electronics parts, for which it designs and fabricates its own dies and molds. It also makes and sells customized dies and molds in limited numbers. The site discussed here has 800 employees, of which 200 are toolmakers. The site has about 50 apprentices currently.

Berg has had an apprenticeship program since 1965. Until 1979, this was a traditional time-based program requiring four years for completion. Then, in the mid 70's, with business increasing, Berg tried to hire additional skilled toolmakers. After an aggressive recruiting campaign costing $80,000, Berg was not able to locate and hire even one skilled worker.

Circumstances thus forced the firm to turn to its own training program. Berg was concerned that its program was not accountable enough--that the firm was not sure of the skills of the journeymen it was producing. The firm also wanted to speed up the learning curve to produce people with the necessary skills in a shorter period of time. Thus was born the current program.

Some of the major features of the Berg program include:

- The length of the program was reduced from four years to three;
- On-the-job practice and training occurs in a separate training facility with dedicated instructors;
- Related instruction is on a need-to-know basis;
- The tasks practiced are based on committee recommendations; and
- Testing is performance-based.

LENGTH OF PROGRAM

The length of the program is set at three years, a reduction of one fourth from the original four-year program. Berg believes that completing its program in three years is a challenging assignment for any apprentice. In addition, the firm wants to accelerate the learning curve and turn out skilled journeymen quickly. Thus the firm elected not to provide time flexibility.

ON-THE JOB TRAINING

The on-the-job training occurs in a separate training setting that is fully equipped with all the machines used regularly in the plant. OJT thus takes place in a dedicated training setting with instructors dedicated full-time to apprenticeship training.

The basic apprentice program is for three years. During the first two years apprentices follow a general program, which takes place in the training facility. During the third year apprentices move out into the plant where they specialize in one of four areas:

- Toolmaker;
- Mold maintenance;
- Die maintenance; or
- Machine maintenance.

After the three year program is complete, a small number of apprentices are selected to continue for a fourth year and an even fewer number to continue into a fifth year of training. These graduate apprentices move into parts fabrication and moldmaking, from which many move into design or technical supervision.

Apprentices' OJT experiences are tightly controlled and monitored, and the number of hours spent on a particular task can be specified and adhered to closely.

Instructors who are skilled journeymen work full-time with the apprentices at a ratio of apprentices to instructors of about 8:1. Apprentices rotate among the instructors so they see a variety of methods of carrying out a task. The firm believes that its program should challenge apprentices to the maximum and that such experience contributes to the apprentice's learning.

A central feature of the training is the use of production work for training. Berg customarily sends out a proportion of its work to job shops for machining. Under the program, apprentices have first crack at this work. Berg believes that using this production work has an inherent interest and appeal to student and teacher alike. Because it is a real job and will be put to actual use, it presents "real" problems. The apprentice knows that the job will be field tested by actual use and therefore takes a greater interest in the success of the job.

Early in the program, Berg was concerned that the plant shops would resist turning work over to the apprentices because the shops are monitored for productivity. Berg overcame this objection by setting up standards for time spent on production. Thus, the plant shops are charged a set amount for a job even though the apprentice may take many more hours to complete the work. There also is close communication among the instructors, other training department personnel, and supervisory personnel about projects to be selected for apprentice work.

There are dangers in using production jobs, however, and Berg takes care not to allow production pressure to crowd out a good learning experience. If a single product or article is produced in too great a quantity, the skills will be repeated beyond the point needed for mastery.

Berg has established certain controls on the use of its production jobs. First, each proposed job is analyzed to determine whether the skills required are those contained in the lesson objectives. Second, the job is selected to fit the instructional sequence. The sequence is not altered to accomodate a job.

RELATED INSTRUCTION

The related instruction provided to apprentices is tailored to each individual apprentice's needs, and is based on what that apprentice "needs to know" to carry out the job. Not all apprentices, therefore, follow the same course of study. At the time of entry into the program, Berg training personnel assess the apprentice's background and experience and develop the instructional program. Someone with a strong background in math, for example, may be exempted from that course. The materials and instructional techniques used vary and may include:

- DuPont program instruction;
- DuPont video;
- Omni video and work books;
- Plant tours; and
- Manufacturer seminars and schools.

TESTING/EVALUATION

Berg uses several methods to evaluate and test apprentices. The heart of the system is the "test block." This is a piece of steel that the apprentice tools according to certain specifications at eight set stages in the apprenticeship. The same piece of steel is used throughout the entire program. The apprentice is allowed three attempts at each level to attain a passing grade of 70 percent.

At the completion of the test block, the apprentice must have an overall score of 90 percent or must redo the entire test block--an exercise that requires approximately 40 hours.

The second way of measuring training results is through a system that measures the monthly progress of the quantity and quality of apprentice work.

Because apprentices are all given production work to train on, one objective is to have all work estimated for time standards against the amount of time required by a skilled toolmaker. The apprentice then is measured against this standard plus a 20 percent allowance. Each month the apprentice receives a report showing his or her progress against the standard and the performance of the apprentices as a whole.

To measure the quality of their work, all apprentice work goes through a tooling inspection department and is evaluated against the print specifications. Each apprentice is judged against a 10 percent scrap allowance. In addition to receiving these two monthly charts, each apprentice receives a monthly performance review that evaluates performance.

JOB ANALYSIS

Berg did not conduct a formal job analysis to determine the content of the training. The content was originally determined by a committee established to plan the program. This committee included both training personnel and line foremen. Content has been altered to meet changing circumstances in the intervening years.

SUMMARY

To sum up, Berg believes that:

> Apprentices must be challenged to their fullest potential on a daily basis.
>
> Training must take priority over production; work must be selected based on training content.
>
> Good communication is a must between instructors and apprentices and between instructors and supervisory personnel.
>
> Theory should be taught on a "need-to-know" basis.
>
> Performance must be objectively and accurately measured to maintain credibility.

Berg is so pleased with the measurement and evaluation part of its program that it is considering implementation of a similar review program to cover its journeymen skilled workers.

Analysis Of Berg Electronics Apprenticeship Program

1. BEST ASPECTS OF THE PROGRAM

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2. AREAS THAT COULD BE IMPROVED

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3. ELEMENTS THAT COULD BE TRANSFERRED

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Tennessee Eastman Company

Tennessee Eastman Company is a unit of the Eastman Chemicals Division of Eastman Kodak Company. The firm produces chemicals used for Kodak's photographic products as well as chemicals, fibers, and plastics for sale to other manufacturers. Among the firm's products is Kodel polyester.

Tennessee Eastman is the State's largest employer with about 13,000 men and women working at its Kingsport, Tennessee site. There are approximately 1,200 skilled craft employees. In November 1983 there were 105 apprentices.

The firm has apprenticeships in the following areas:

- General mechanic;
- Pipefitter;
- Metal fabricator;
- Machinist;
- Control systems mechanic (combining electrician and electronics repair); and
- Structural fabricator.

Tennessee Eastman began its current program in 1975 to replace its traditional time-based program, which had been in existence since 1936.

There were several related and compelling reasons for the switch to the current program. First, the company realized that the average age of its skilled craft workers was rising, posing a problem of a sudden and severe loss of manpower ten to fifteen years in the future. The firm realized that it had to take steps to perpetuate the skills of its workforce. Second, there was a growing displeasure with the skills of the apprentices graduating from the then current program. In the early 1970s, a committee was assigned the task of evaluating the four-year program. The committee considered alternative methods to provide for:

- Better trained mechanics;
- Increased apprentice motivation; and
- Increased training efficiency.

They hoped to accomplish this by:

- Development of objective performance and training standards;
- Flexibility of time in training; and
- Development of objective methods to measure apprentice accomplishment.

As a result of the Committee's recommendations, Tennessee Eastman revamped its program to provide for:

- Flexible time requirements, with a three-part program and individual courses;
- Self-study materials and laboratory work in each course area;
- On-the-job training that parallels the course work; and
- Testing for individual courses and comprehensive skill and written tests for each of the three parts.

FLEXIBLE TIME REQUIREMENTS

The program for each apprentice at Tennessee Eastman is divided into three major parts. Each part contains a discrete number of courses--or modules--that address the major job requirements for that particular apprenticeship. Part completion time is flexible, ranging from a required minimum of six months to a maximum of two years. The total program, therefore, can range from 18 months to six years. The philosophy of this self-paced approach is to enable each apprentice to progress at his or her individual speed.

RELATED INSTRUCTION

Each of the three parts of the program is divided into 10 to 12 separate courses that cover essential job knowledge-skill elements.

Apprentices use a self-teach approach for the theory part of the courses. Apprentices are required to attend a 3.5 hour session each week after work where they review written text materials, slide/tapes, video tapes, and other materials that relate to the courses. The written materials and textbooks are generally purchased from vendors. Most of the video and slide materials have been produced in-house. (After all, this is Kodak!) Instructors are available at the study center to answer questions.

Most self-study courses are followed by hands-on lab instruction. Lab training provides practical application of the concepts and techniques studied.

The lab itself is a two-story converted warehouse that contains several dozen individual training rooms equipped with the materials and machines used on the job. An apprentice is scheduled into a lab session as soon as possible after course completion.

Individual hands-on lab sessions are scheduled in four or eight hour time blocks. Post-course labs may range from four to forty hours depending upon the skill performance level requirement. Normally, four apprentices are scheduled for lab work with an instructor. The instructional personnel are selected skilled mechanics.

ON-THE-JOB TRAINING

The on-the-job training an apprentice receives parallels knowledge and skill training obtained in the study center and labs. This is possible because of the support and cooperation the program receives from the first-level supervisory personnel responsible for overseeing the skilled craft work.

TESTING

Testing plays a large role in the program. Apprentices entering into a part may "test out" of individual courses by taking a written pretest designed by the training staff. At the completion of each study center course, an apprentice must pass a written test before proceeding to the hands-on lab. Apprentices also must pass a comprehensive written test at the end of each part and a performance test conducted in the lab. This performance test takes approximately 16 to 20 hours. The apprentice has three attempts at each test. After a failing attempt, an apprentice receives remedial study or lab work in the areas of unsatisfactory performance.

Tennessee Eastman devotes considerable attention to test construction, analysis, review, and validation. The training department has developed more than 700 tests from the approximately 15,000 questions they maintain in their computer system.

JOB ANALYSIS

The content foundation for the entire program is based on a systematic job analysis of each craft area. The job analysis includes:

- Identifying trade tasks;
- Obtaining man-hour expenditure data on tasks;
- Determining the significance of tasks;
- Detailing selected significant tasks; and
  Identifying knowledge and skills required for tasks.

Since the start of the program, job analysis data have been reviewed every several years to identify needed changes in the knowledge and skill requirements.

Tennessee Eastman uses the line foremen supervisory personnel to conduct the job analysis. Each fills out a series of questionnaires which are then analyzed by computer.

LINE SUPPORT

First-line supervisory personnel are the primary resource in developing the job analysis for each craft. They also serve as instructors on a rotating basis in the hands-on lab. In addition, the foreman in whose crew an apprentice serves must sign a sheet specifying that he or she believes the apprentice is prepared to take the comprehensive part test.

Tennessee Eastman training department staff believes that this input is an essential element in the success of the program. The foremen have: (1) created the curriculum; (2) helped to train the apprentices; and (3) signed on the dotted line that an apprentice is prepared to pass the major tests. The foremen, therefore, have a lot invested in insuring that apprentices do indeed succeed.

The result, training department officials say, is complete cooperation in the assigning of OJT tasks to apprentices and a generally supportive working environment for apprentices. Practically all skilled mechanics in the plan are apprentice graduates. Indications are that plant maintenance productivity has increased. This is due in part to more competent skilled mechanical forces, resultings from the self-paced apprenticeship training program.

Analysis of Tennessee Eastman Apprenticeship Program

1. **BEST ASPECTS OF THE PROGRAM**

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2. **AREAS THAT COULD BE IMPROVED**

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3. **ELEMENTS THAT COULD BE TRANSFERRED**

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MODULE 4
PERFORMANCE-BASED APPRENTICESHIP TRAINING

ATR GUIDEBOOK

Characteristics Of
Performed-Based Apprenticeship Training

Performanced-based apprenticeship training has certain characteristics:

- Job Analysis is performed prior to designing the training.
- Training content is based upon tasks, which are measurable.
- Apprentice performance objectives are specified in advance of instructions.
- Instruction is individualized.
- Theory training focuses on knowledge and theory needed to perform on the job.
- Learning is guided by feedback.
- Learning time is flexible.
- Criterion-referenced measurement is used to evaluate the attainment of performance objectives.

Traditional (Time-Based) VS. Performance-Based Apprenticeship Programs

There are some obvious differences between the elements of performance-based training and traditional time-based apprenticeship programs. In contrast to performance-based programs, in traditional apprenticeship:

- The overall training content usually is not organized into specific tasks required to achieve competency in a skilled trade.
- Performance objectives are not specified.
- Completion of the apprenticeship does not require the demonstration of competency in specific job areas.
- An individualized program of training usually is not specified.
- Regular systematized feedback on achievement is not required.
- A specified period of time is required to complete a traditional apprenticeship.
- Related instructional programs are not related to the specifics of performing the job.
- Testing occurs only on related instruction. Criterion-referenced tests are not used to measure job performance.

The major differences between traditional time-based and performance-based programs relate to the specification of what will occur in a program and how it should be measured, and the correlation of related instruction with the on-the-job experience.

Developing and Installing A Performance-Based Apprenticeship Program

The Sale

ATR

- Reaches gatekeepers and decisionmakers
- Understands company's personnel needs
- Explains benefits/costs of P-B program
- Offers TA/resource help

TRAINING DIRECTOR

- Sees need for change in program
- Supports development of P-B program
- Has trust in ATR's skill and promises

SR. MGT.

- Has a need for trained workers
- Runs a growing business
- Is unhappy with current programs
- See benefits in program

Developed and Installing
A Performance-Based Apprenticeship Program
Program Development

ATR

- Provides technical assistance at all stages
- Maintains ongoing contact with the firm
- Suggests appropriate resources and materials
- Acts as a "sounding board"

TRAINING DIRECTOR

- Conducts task analysis
- Develops job performance objectives including job conditions and standards
- Develops selection criteria
- Determines instructional techniques, materials, sequence, and testing techniques
- Develops, obtains materials for instruction/testing

SR. MGT.

- Provides continuing support
- Reviews task analysis
- Gives input regarding performance objectives
- Provides financial support

MODULE 5
JOB ANALYSIS

REFERENCE MATERIALS

Job Analysis

Job analysis is describing a job in terms of the tasks involved in that occupation. A job analysis is based on observations of worker(s) deemed most successful at the particular job.

Job analysis is important because the data collected provide the foundation upon which a training program is built. Regardless of how well subsequent program development is carried out, if the job analysis data are not complete, valid, and reliable the program designed will not produce acceptable workers. A properly done job analysis contains the exact tasks that must be mastered to be a successful worker in a given occupation.

JOB ANALYSIS QUESTIONS

A good JA will provide enough information to answer the following questions:

1. **What does the job consist of?** What are the duties and tasks of the job? What knowledge does the worker need to be successful?

2. **How is it performed?** What are the movements and actions of the job? At what rate of speed must the trainee learn to operate?

3. **Why is it performed?** What is the importance of the job? Why is it done?

4. **How does it relate to other jobs?** Where does it fit in the hierarchy? Is the product of the job used for another operation?

5. **Under what conditions is the job performed?** Is it indoors or outdoors? Are human relations skills required?

6. **What are the standards of acceptable performance?** Will the trainee have to be trained to do exacting work? Are math skills important?

7. **What are the frequency and criticality of specific tasks?** How often is the duty or task performed? How important is it to successful job performance?

8. **What equipment and materials are used?** What type of tools must a worker learn to handle? Will skills in metalworking, woodworking etc. be necessary?

When conducting a complete and thorough job analysis, the analyst must ensure that field expedients and stop gap measures are not allowed to take the place of proper technique and methodology. For example, even though it

is written in the manual that she should, an operator may not shut off her machine before clearing a jam. The reason she gives is that it is faster to clear a jam with the machine still running. Clearly, however, this is a safety hazard. A good job analysis will not permit this behavior to become part of a training program even if 90 percent of the successful workers observed have their machine running when clearing a jam.
It may be wise to have management and supervisors review the duties and tasks that have been collected. If this is not done, their perspectives on a job may be lost. Going one or two steps higher than the actual worker can be very helpful in developing a training program.

STAGES IN JOB ANALYSIS

Answering all the above questions requires a number of steps, divided into two stages.

Phase 1: Assessment

- Listing all the tasks included in a job;
- Assessing the frequency of performance of the task;
- Assessing the importance of the task; and
- Estimating the difficulty of a task.

Phase II: Task "Editing" and Subtask Specification

- Specifying subtasks for the tasks to be included;
- Specifying related tasks; and
- Specifying performance requirements and difficulty.

This body of information provides the basis of structuring the training program and its content areas. Factors that should be specified in a job analysis include:

- Frequency of performance;
- Importance of the task; and
- Difficulty of the task.

After the analyst has detailed the major tasks and performed an assessment of their frequency, importance, and difficulty, he or she needs to select which tasks will be contained in the training.

This can be done both by weighing the information assembled on frequency, importance, and difficulty and by breaking each task down into subtasks. This subtask specification is necessary for the detailing of the training program and also to determine which tasks have subtasks in common that may be combined into preliminary basic training. Care and maintenance of equipment or the use of hand tools may fall into this category.

Detailing subtasks is the listing of all the steps to be performed in carrying out a task. These include:

- Recognizing when to perform a task;
- Selecting the appropriate tools and materials;
- Performing safety procedures associated with the task;
- Locating the correct objects on which to work;
- Identifying the sequence of steps;
- Describing the theory of why something works; and
- Reognizing the differences between work performed properly or improperly.

Once all the subtasks are specified, there is one more step. This is to identify the type of performance that would be involved in learning a subtask and the difficulty of the learning. Types of performance could be:

- Manipulative;
- Problem-solving;
- Recall;
- Judgement or discrimination; and
- Combinations of the above.

OTHER TECHNIQUES FOR JOB ANALYSIS

There are a number of methods that can be used to perform the job analysis. Some methods involve interviewing skilled workers to elicit their views on what is required to perform their jobs; others involve observing and documenting what skilled workers do on the job; still others involve "brainstorming".

JA According to Fine Associates

Fine Associates Incorporated, a consulting firm, conducted a functional job analysis of selected operating engineers. Data were collected by:

- Visiting training centers and job sites;
- Observing operating engineers at work;

- Interviewing operating engineers; and
- Riding on and manipulating equipment controls.

On the worksheets, Fine Associates included the following:

- A data function scale (Level 1 Comparing through Level 6 Synthesizing)
- A people function scale (Level 1 Talking through Level 6 Negotiating)
- A things function scale (Level 1 Handling through Level 3C Operating - Controlling II)
- A worker instruction scale (Level 1 Specified Amount of Work through Level 8 High Supervisory skills)
- A reasoning development scale (Level 1 Simple Concrete Actions through Level 6 Highest abstract)
- A mathematical development scale (Level 1 Simple Math through Level 5 Advanced Math and Operations)
- A language development scale (Level 1 Simplest Level of Understanding through Level 6 Report, Write, and Edit)

DACUM

DACUM (Developing a Curriculum) is an approach to job analysis developed at the Ohio State University (The National Center for Research in Vocational Education).

The National Association of Boards of Barber Examiners used DACUM to define the occupation of barbering. The Trident Technical College used it to define the tasks of an industrial mechanic. DACUM also is used extensively in Canada.

Basically, DACUM is a modified brainstorming process. Workers interact together in the presence of a trained DACUM facilitator to develop a profile of the skills required in an occupation. To perform DACUM correctly you need:

- A qualified DACUM coordinator;
- 8-10 expert workers brought together in a room;
- 2-4 supervisors of workers; and
- 2-3 day workshops.

The philosophy of DACUM is that:

- Expert workers are best able to describe/define their occupation;

- Any job can be effectively and efficiently described in terms of the duties successful workers perform; and
- All tasks have direct implications for the knowledge and attitudes that workers must have to perform tasks correctly.

THE FEDERAL GOVERNMENT AND JA

The federal government has done a great deal of work in the area of job analysis. The Dictionary of Occupational Titles contains almost 17,500 concise job definitions.

FOLLOW UP

Once the job analysis is complete and a training program developed, followup and validation should occur. Doing a follow-up is important to determine the appropriateness of the training program. The analyst needs to examine how well the training program--based upon the job analysis--matches the job and to determine what is actually being done on the job and how well the trainee is able to perform.

Follow-ups can be conducted by personal interviews, interviews over the telephone, and by mail questionnaires. The analyst is trying to determine how well the ex-trainee is performing on the job. If the ex-trainee is not performing well, the analyst should find out why.

MODULE 5
JOB ANALYSIS

EXERCISE MATERIALS

Exercise
Job Analysis

DIRECTIONS

Chart I

On Chart I: Task Listing Sheet, list all the major duties for the job of auto mechanic. These should be major duties -- i.e. transmission repair, engine tune up. For each major duty, specify the frequency, importance, and learning difficulty. Do not proceed to the second sheet until directed by the instructor.

Chart II

On Chart II: Subtask Detailing Sheet, list all the major subtasks for one task from the Task Listing Sheet. Note the importance and learning difficulty of the subtask.

Task Listing Sheet

Tasks	Frequency of Performance [a]	Importance [b]	Learning Difficulty [c]

(a) Use:

1 = Often
2 = Occasional
3 = Rare

(b) Use:

1 = Most
2 = Moderate
3 = Least

(c) Use:

1 = Difficult
2 = Moderate
3 = Easy

Subtask Detailing Sheet

Task: ______________________________

Steps in Performing the Task	Type of Performance (a)	Learning Difficulty (b)

(a) Use:

Manipulative
Problem-solving
Recall
Judgment
Combination (Specify)

(b) Use:

1 = Difficult
2 = Moderate
3 = Easy

MODULE 5
JOB ANALYSIS

ATR GUIDEBOOK

Job Analysis

A good JA will provide enough information to answer the following questions:

1. **What does the job consist of?** What are the duties and tasks of the job? What knowledge does the worker need to be successful?

2. **How is it performed?** What are the movements and actions of the job? At what rate of speed must the trainee learn to operate?

3. **Why is it performed?** What is the importance of the job? Why is it done?

4. **How does it relate to other jobs?** Where does it fit in the hierarchy? Is the product of the job used for another operation?

5. **Under what conditions is the job performed?** Is it indoors or outdoors? Are human relations skills required?

6. **What are the standards of acceptable performance?** Will the trainee have to be trained to do exacting work? Are math skills important?

7. **What are the frequency and criticality of specific tasks?** How often is the duty or task performed? How important is it to successful job performance?

8. **What equipment and materials are used?** What type of tools must a worker learn to handle? Will skills in metalworking, woodworking etc. be necessary?

Steps in Job Analysis

Phase I: Assessment

- Listing all the tasks included in a job;
- Assessing the frequency of performance of the task;
- Assessing the importance of the task; and
- Estimating the difficulty of a task.

Phase II: Task "Editing" and Subtask Specification

- Specifying subtasks for the tasks to be included;
- Specifying related tasks; and
- Specifying performance requirements and difficulty.

Phase III: Follow Up

- Personal interviews;
- Telephone interviews; or
- Mail-in questionnaire

Task Listing Sheet

Tasks	Frequency of Performance [a]	Importance [b]	Learning Difficulty [c]

(a) Use:

1 = Often
2 = Moderate
3 = Seldom

(b) Use:

1 = Most
2 = Moderate
3 = Least

(c) Use:

1 = Difficult
2 = Moderate
3 = Easy

Subtask Detailing Sheet

Task: ______________________________

Steps in Performing the Task	Type of Performance (a)	Learning Difficulty (b)

(a) Use:

Manipulative
Problem-solving
Recall
Judgment
Combination (Specify)

(b) Use:

1 = Difficult
2 = Moderate
3 = Easy

MODULE 6
INDEPENDENT MODULE DEVELOPMENT

REFERENCE MATERIALS

Independent Module Development

A module is considered to be a "learning package" that contains:

- A description of what is to be learned;
- Instructions to guide trainees through the learning process; and
- Appropriate materials to use during the learning process.

Modular training is organized into discrete tasks or segments; it provides hands-on experience as a principal component of the learning; and it is self-paced and self-directed by the trainee.

It helps to ensure effective learning by:

- Providing a wide variety of learning resources and materials, such as books, media, and hands-on practice;
- Providing materials that can be used at the student's own pace;
- Providing structure to the learning process;
- Organizing the learning by tasks;
- Providing continuity -- when the instructor leaves, the training program remains; and
- Including built-in checkpoints for assessing trainee progress.

TYPES OF MODULES

If a modular approach is adopted, what should these modules look like? Does a company have to spend several million dollars in developing a training lab, putting together video tapes, and the like? The answer is no. The modular approach is a philosophy as well as a set of materials. Companies can adopt several different approaches that would vary greatly in cost while still maintaining most of the benefits of the modular philosophy.

There are three common designs:

- The trainee direction sheet;
- The learning guide; and
- The self-contained learning package or "module."

Trainee Direction Sheet

The trainee direction sheet is a single sheet or a few sheets of paper that include a list of directions for accomplishing a task.

A direction sheet can be prepared quickly, at low cost, and can be revised easily. On the other hand, using the learning sheet requires that the program rely on already developed materials. It is also difficult to incorporate checkpoints and feedback into the process and it does not include formal written or performance tests.

Self-Contained Learning Package or Module

At the other end of the spectrum is the self-contained learning package or module. This is a complete package that contains all learning materials. It includes detailed instructions, pictures, diagrams, self-tests, pre-tests, and post-tests. Trainees would perform their job-related tasks based on the directions and instructions provided. An instructor would be available to answer questions and to correct the tests. This type of package is self-contained, carefully designed, and has a finished professional look. It is also time-consuming to develop.

The Learning Guide

The learning guide occupies a sort of middle ground between the two. It guides the student through a variety of commercially produced and instructor-developed materials, and provides for hands-on instruction. It also includes pre- and post-tests.

This method takes advantage of existing materials and provides both flexibility and accountability. It ensure checkpoints and evaluations and can be adapted to meet changing circumstances.

It is important to note that developing a good learning guide type of module does not require a separate training facility.

It would require, however, that some method be established to ensure that the on-the-job training be coordinated with the related instruction and that some method be established for measuring progress as apprentices progress through the program.

The PETS Program

The carpentry apprenticeship program developed by the United Brotherhood of Carpenters and Joiners of America is known as the PETS program. This acronym stands for Performance Evaluated Training System. The program's name describes its basic philosophy -- a training system that uses performance as the criterion for evaluation. This differs from traditional apprenticeship programs in that apprentices must prove that they can perform a specific, comprehensive set of tasks at specified proficiency levels. While learning these tasks, apprentices acquire the knowledge and skills carpenters need to meet current industry demands.

The PETS program was developed when an examination of traditional apprenticeship programs showed them to be largely irrelevant to worker and employer needs; they were infinitely more theoretical than practical. In most of these programs, students attend classes in vocational or technical schools, where they use textbooks to learn about their craft. Although these classes are occasionally supplemented with shop work, these shop activities usually consist of building small scale models that do not provide real work, i.e., hands-on experience. Often, the tools used in shop classes do not replicate those used in the field. In addition, the textbooks usually focus on residential housing, despite the fact that most union apprentices work on industrial construction projects. To complete traditional programs, apprentices are usually given written tests of materials studied. Many of the skills they will need to work effectively as union carpenters are seldom taught or assessed. The Brotherhood could not influence the type of training offered in these vocational schools.

Another problem in traditional carpentry apprenticeship programs recognized by the Brotherhood is that apprentices' on-the-job training (OJT) experiences are often with contractors who specialized in only one narrow area of carpentry work (drywall, roofing, etc.). This specialization of labor, which seems to be a trend in construction and many other industries, limits the amount of practical experience apprentices gain. Apprentices often complete their entire apprenticeships having had experience in only a few areas of carpentry.

In 1976, the Brotherhood developed a set of objectives which has come to form the backbone of the PETS program.

PROGRAM OBJECTIVES

The objectives developed by the Brotherhood include the following:

- Provide apprentices with a practical way of acquiring the skills and knowledge needed by carpenters;

- Present a method of objectively evaluating apprentices' applied skills and knowledge based on achievements rather than on the amount of time spent in the program;
- Assure that the apprentices' skills and knowledge are relevant to current construction industry needs; and
- Provide a method for apprentices to receive a variety of relevant hands-on carpentry experiences even if they do not obtain a variety of work experience through their on-the-job training.

PROGRAM DEVELOPMENT

To meet these program objectives, the Brotherhood took the following steps:

- A complete job analysis was made of tasks carpenters perform on construction projects in all aspects of their trade. This analysis was completed with the use of thousands of photographs, interviews with expert carpenters, supervisors, contractors, and a number of others who had worked closely with carpenters' apprenticeship programs for many years.
- The photographs were edited and a set of slides was compiled for each task. Each set showed how that task should be done from its initiation to completion.
- A set of blueprint sections and detailed drawings was compiled to accompany the slides. The drawings, termed "manipulative drawings," resemble small blueprints for each task presented. They are adapted by local program coordinators who take into consideration local construction practices and materials, available space, and program time schedules.
- An outline of all the tasks to be learned by carpenter apprentices was formulated into major skill sections, each broken into numerous skill blocks for the separate tasks required.
- Implementation materials and administrative forms were designed to assist apprenticeship program coordinators in setting up and running PETS programs.
- The PETS program materials were then pilot-tested at 10 locations. All materials were critiqued for accuracy and content, and a number of modifications reflected changes proposed in these critiques. (These pilot tests began in 1977, and feedback from the pilot programs are still being received. New task areas are constantly being developed, and revisions are made in current task areas to reflect changes in the industry.)

APPRENTICES IN THE PETS PROGRAM

Entry Into the PETS Program

Apprentices enter the PETS program through procedures determined by their own Joint Apprenticeship and Training Committees (JATCs). The United Brotherhood strongly endorses an open-entry policy, which encourages programs to admit all applicants to apprenticeship if they meet minimum entry requirements. However, local JATCs have considerable autonomy in determining their own entrance procedures.

Orientation

After acceptance into the program, apprentices begin their PETS training with a basic orientation to the program. This orientation ensures that apprentices can become safely and productively employed at the earliest possible time. Through instruction and practice, the orientation teaches apprentices the proper use of hand and power tools to be used on their first assignments as well as general safety procedures. In addition, apprentices learn the structure of and process for advancement through the PETS program.

First Learning Assignment

Following orientation, the first learning assignments for apprentices are the skill sections that correspond to the jobs apprentices hold for their on-the-job training (OJT). If apprentices remain working in a single area for a considerable length of time, they will also remain in that appropriate skill section until they have completed at least 80 percent of the skill blocks within that section. If apprentices change jobs before 80 percent of a skill section is completed, they move to the appropriate new skill section and return later to complete at least 80 percent of the first section. This permits apprentices, as much as possible, to work and train in the same area simultaneously.

Given the specialized nature of much of the construction industry and the current slump in many types of construction, apprentices are very likely to remain with a single contractor for a long time. If that contractor only offers one type of work, the apprentices may repeat the same work assignments for many months. Yet they will receive a variety of hands-on training experiences while completing their PETS projects. These experiences prepare apprentices for the time when they may be able to change jobs and obtain work experience in other areas as economic conditions improve in the construction industry.

Progression Through the PETS Program

Apprentices progress through the PETS learning program at their own pace. They begin a learning assignment (skill block) by viewing a set of slides that explains and illustrates the steps that must be taken and the skills needed to complete an exemplary project typical of real work projects in that skill area.

After viewing the slides, apprentices may ask their instructors to explain anything that is unclear to them.

Although apprentices usually view the slides individually, sometimes two or three apprentices ready for the same set of slides at the same time look at them together. The apprentices can rerun the slides as many times as necessary until they fully understand them.

When apprentices think they understand the material on the slides, they ask their instructors for the corresponding manipulative drawings from which they will build their projects for those tasks. Next they check out the tools, lumber, and other materials they will need. They take all these things to assigned work areas and begin building their projects according to the specifications on the drawings. If they have difficulty completing their projects, they may return to the viewing area and review the slides again, or ask an instructor for assistance. Most projects are completed by each apprentice working alone, with the exception of a few projects that physically require at least two people to perform them.

When apprentices think they have successfully completed their projects, they ask their instructors to inspect them. Instructors examine the projects to see that they are built according to the specifications on the manipulative drawings in conformance with current construction standards for that area.

Apprentices sometimes work together in small groups. However, no more than approximately 1/6 of apprentices' learning experiences are conducted in group situations. Topics that lend themselves best to group sessions are the following:

- Orientation;
- Safety and first aid instruction;
- Remedial math instruction;
- Basic blueprint reading;
- Welding (depending on shop layout);
- Optic instruments-general processes; and
- Topics such as "slip-form construction," which require two or more apprentices to complete the task assignments.

These few group sessions are convened as needed when several apprentices require instruction in these areas at the same time.

The ideal project drawing allows apprentices to complete projects without interruption, scaled to size. For example, the drawings may require apprentices to build only four or five stair risers instead of eight or ten, but each riser is constructed with realistic dimension and full-sized lumber. In the PETS program, apprentices do not build little models of big projects. In most cases, they construct full-sized sections of those projects. In all instances, apprentices use the regular tools and materials used for carpentry construction in that locality.

Completing the PETS Program

There are 60 different skill blocks in the PETS program. Apprentices must complete 80 percent of the blocks in each section, for a total of 48 skill blocks. In addition, apprentices must complete all the skill blocks in Section 1, for a total of 52 skill blocks required for completion.

Apprentices are entitled to consideration for advancement (pay increase) upon the completion of each six blocks of training.

Apprentices may acquire credit for the completion of skill blocks in three different ways:

- By **working within the program structure as outlined above** -- Apprentices use the PETS visual instruction materials and instructor assistance as needed. Apprentices build PETS projects to specification and those projects are evaluated by instructors, who give credit upon successful project completion.

- **By challenging** -- Apprentices may offer to construct PETS projects to specification without using the visual materials and without assistance from instructors. These projects must also be evaluated by instructors. Credit is given upon successful project completion. Apprentices who challenge a project are often those who have had prior carpentry work experience or training before entering the PETS program.

- By **on-the-job supervisor evaluation** -- Apprentices may ask their job supervisors or their apprentice coordinator to evaluate their on-the-job work experiences for credit for successful project completion. This action is often requested when apprentices gain work experience comparable to a PETS project before they have an opportunity to complete that project at the learning center.

If supervisors evaluate apprentices as competent in a skill area and there is any question on the part of program coordinators regarding that competence, apprentices may be asked to build projects at the learning center and be re-evaluated on the basis of those projects. In all evaluations, an acceptable degree of quality must be maintained in the design and construction of projects. Area industry quality standards must be followed and apprentices will not receive credit for work that does not meet those standards.

When credit is given for successful completion of skill block projects, copies of the manipulative drawings used and apprentices' evaluation sheets are placed in the permanent files. This procedure assists in evaluating apprentices who transfer from one program to another. The new JATC can review the type and quality of work performed and make any training adjustments necessary to bring apprentices' training in line with local program standards.

INSTRUCTORS IN THE PETS PROGRAM

Instructors in the PETS program act as resource people for apprentices. They are competent craftspersons who can assist apprentices in any area of carpentry. Within a given program, some instructors may know one area of carpentry better than another. These instructors are often directed specifically to assist apprentices who need help in that program area.

Within the PETS program, instructors are "walking resources" who are available to assist apprentices when they actually need help. This help may be required to interpret manipulative drawings, explain procedures shown on slides, solve particularly difficult construction problems, or simply provide encouragement. By using instructors in this manner, the PETS program can make optimal use of instructors' expertise when apprentices actually need assistance.

PETS PROGRAM FACILITIES

The facilities used to carry out a PETS program vary from rented warehouse space, to modified unused school buildings or Air Force bases, to new buildings designed and built specifically for PETS program use. Some programs operate by using a combination of high school shop space, vocational school facilities, and parts of a warehouse. The main requirement for a good PETS program facility is space and lots of it -- approximately 100 square feet of working area for each apprentice working in the facility at any one time. In addition, there must be lumber storage areas, slide viewing areas, office space for a coordinator and instructors, and places to safely store and retrieve records, tools and slides. A classroom/lunch room may be needed, and restroom facilities must, of course, be included.

The working area needs to be open and high enough to permit construction of projects well over 8 feet tall. The floor surface should resemble real construction conditions for carpenters, i.e., partly rough dirt, some cement, and some wooden flooring. Some programs have obtained their facilities with as little as a $1.00 fee for an unused school building! Other programs have built elaborate buildings that cost several hundred thousand dollars. Facilities, materials, and instructors' salaries may be paid for in a variety of arrangements including use of JATC training trust funds, state assistance, federal CETA training funds, or combinations of the above. In most programs, apprentices supply many of their own tools, and also use them on their jobs. Some programs charge apprentices a small fee to cover partial material costs, similar to textbook fees in other programs.

PLANNING AND IMPLEMENTING A PETS PROGRAM

Careful, up-front planning is a crucial element for PETS program success. Planning must continue throughout the program as apprentices enter and leave, as new construction techniques are locally introduced, and as new tools and materials come into use. Planning for a PETS program involves much more than simply reviewing textbooks and tests for classroom use, as required by most traditional programs. The PETS program coordinators must arrange for tools, materials, drawings, and space to be ready when apprentices need to use them. Even a small program with only 15-18 apprentices may have 15-18 different projects under construction during a single learning session. Each of these projects must be prepared for in advance. Materials must be ordered, delivered on time, stored, used and reused until only scraps remain -- which also must be disposed of.

Some PETS learning centers offer program training on three consecutive nights a week; some have alternative evening schedules for two shifts of apprentices; some have apprentices come to a center for all-day sessions for two or three weeks, etc. These different training schedules affect the projects that apprentices can build, the amount of floor space available, the ordering of materials, and all other program factors.

The Brotherhood provides a handbook for program coordinators who plan and implement PETS programs. It includes brief summaries of guidelines for a shop layout; suggestions for some prebuilt, semi-permanent props; scheduling suggestions; discussion of how to use sectionalized projects; descriptions of what to include in program orientation sessions; directions of how to choose instructors; and sample record keeping systems. The Brotherhood also sends field representatives to new programs to help them plan and prepare for the implementation of their programs.

MODULE 6
INDEPENDENT MODULE DEVELOPMENT

EXERCISE MATERIALS

Module Development

Using the spaces provided below, outline a module to be used in a training program for auto mechanics. Select one task from the list of tasks you developed earlier for your job analysis. Refer to the module that follows these worksheets for guidance, if necessary.

Competency area:

Title of Module:

Objectives:

What you need:

What you will do:

How well:

Purpose:

Materials and Equipment:

Steps in the Process:
(Use as many as needed)

1.

2.

3.

4.

5.

Here is How:

1.

2.

3.

4.

5.

Performance Criteria:

1.

2.

3.

4.

5.

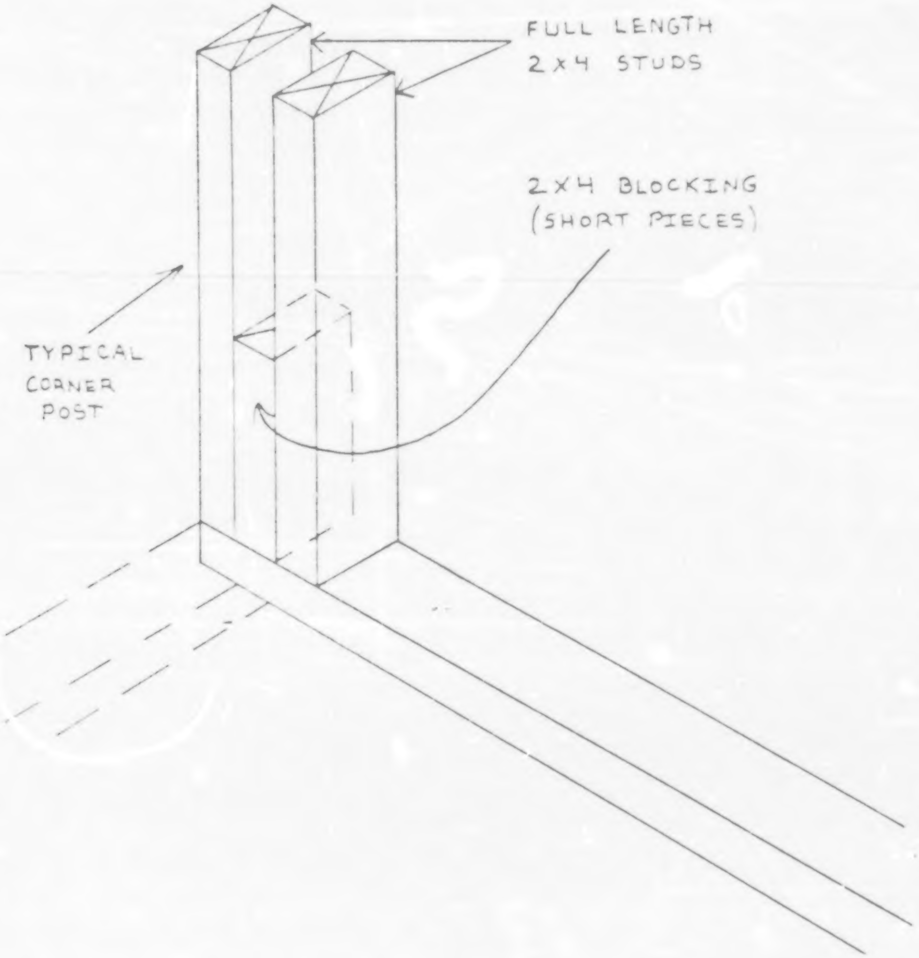
6.

7.

8.

Carpentry
CAG 860 E1: Lay-Out Plates and Rough Openings on Exterior Walls

U.S. Department of Labor
Employment and Training Administration
Job Corps


FULL LENGTH
2x4 STUDS
2x4 BLOCKING
(SHORT PIECES)
TYPICAL
CORNER
POST

BEST COPY AVAILABLE

Contents

DOT 860

COMPETENCY AREA 860 E: Complete Rough Framing Work

CAG 860 E1: Lay Out Plates and Rough Openings on Exterior Walls

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Carpentry
CAG 860 E1: Lay-Out Plates and Rough Openings on Exterior Walls

U.S. Department of Labor
Raymond J. Donovan, Secretary of Labor

Employment and Training Administration
Albert Angrisani, Assistant Secretary of Labor

Job Corps
Charles Atkinson, Acting Administrator of Job Corps

August 1982

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CAG 860 E1: Lay-Out Plates and Rough Openings on Exterior Walls

Objective

What you need.	2 x 4 plates, and basic carpentry hand tools
What you will do. . . .	Lay-out rough openings and stud locations on top and bottom plates
How well.	So that your plate marks are within ± 1/8 inch of specifications

If you feel able to meet this objective now, turn to the Performance Criteria on page 13.

urpose

To start framing a building you must mark where the studs and openings will be. These marks are put on the top and bottom plates of the frame. "Laying out a plate" means marking the bottom 2 x 4 piece to show exactly where each part of the frame goes. In this unit you will learn how to mark the location of each:

- Corner post
- Rough opening
- Stud

Materials and Equipment

- 2 pieces of 16' long 2" x 4"
- 1 combination square
- 1 pencil
- 1 16' metal tape

Skills You Need Before You Begin

CAG 860 A1: Describe the Carpentry Trade
CAG 860 A2: Practice Safe Work Habits
CAG 860 B1: Demonstrate Skill in Using Measuring Tools
CAG 860 B2: Demonstrate Skill in Using Testing Tools

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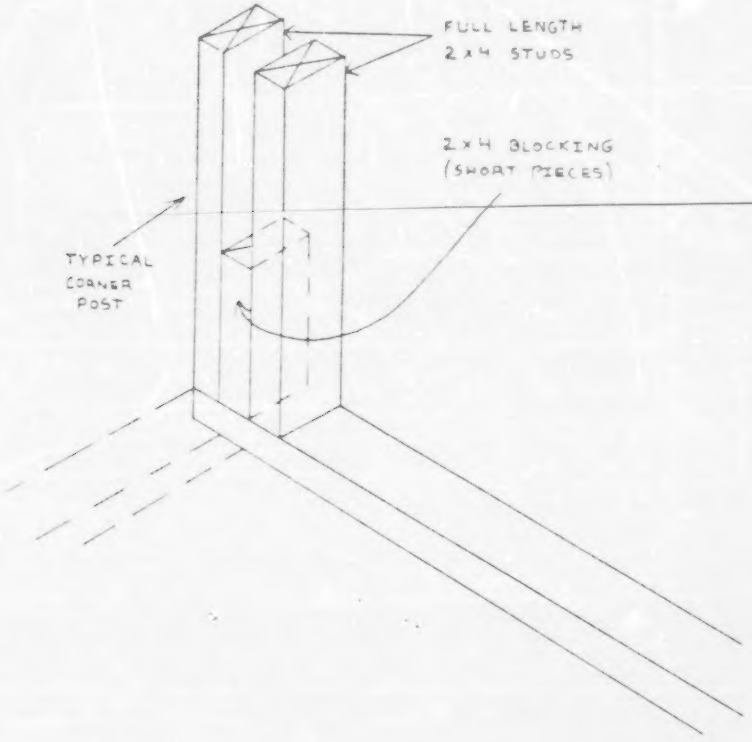
STEP 1. Lay out the corner post.

NOTE: The corner post is the framed structure in the corner of a wall. (See Working Drawing)


FULL LENGTH
2 x 4 STUDS
2 x 4 BLOCKING
(SHORT PIECES)
TYPICAL
CORNER
POST

(Working Drawing)

Here's how:

a. Find the end of a 10-foot piece of 2 x 4 (see Working Drawing). Clip or hang the end of the tape over the 2 x 4.

b. Measure 1 1/2" in on the wood.

- Mark this with a pencil (see Figure 2).

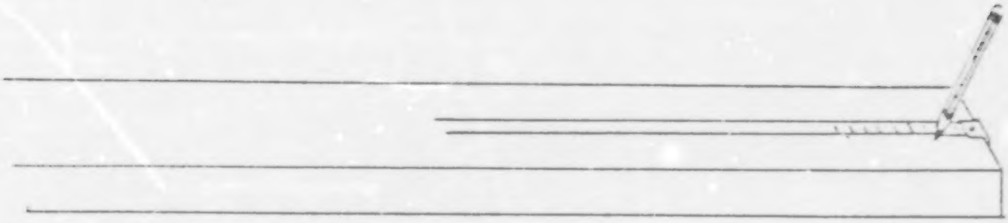


Figure 1.

c. Draw a circle around this mark.

d. Use your combination square to square off (draw a line) across the 2 x 4 straight through to the mark just made.

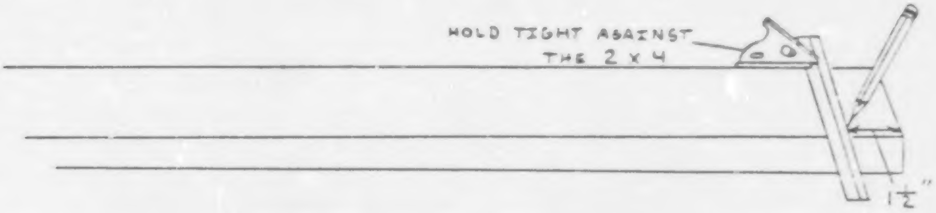


Figure 2.

e. Mark an "X" in the space to show the place to put a full length 2 x 4 (see Figure 3).

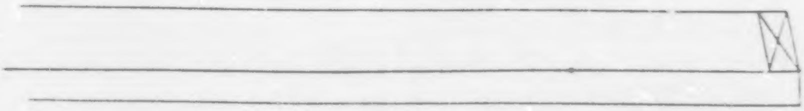


Figure 3.

f. Mark over from the last mark another 1 1/2". This will show the space for blocking (short pieces of 2 x 4). Use the combination square as shown in (d).

g. Mark over from the last mark another 1 1/2". This will show the location of the full length 2 x 4. The plate should look like Figure 4.

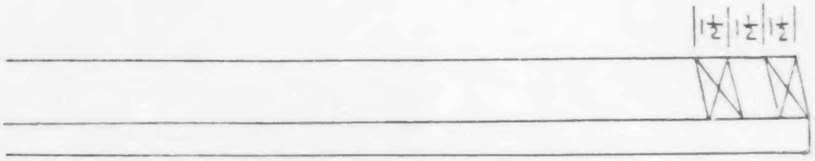


Figure 4.

h. Repeat steps a, b, c, d, e, f, g from the other end of the stud.

STEP 2. Lay-out and mark center lines.

Here's how:

a. Start with a 16' piece of 2 x 4 as shown in the Working Drawing. Hold the tape at one end and run it to the other end. Lock the tape in place (see Figure 5).

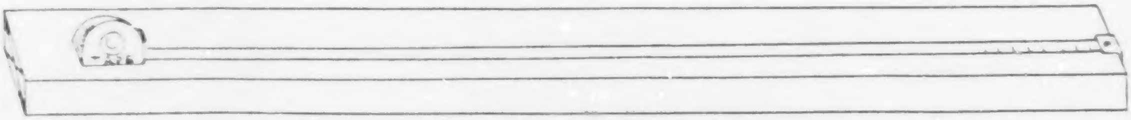


Figure 5.

b. Look at Working Drawing for center line dimensions.

c. Measure 4'0" from each end of the 2 x 4. Put a pencil mark and circle around it (see Figure 6).

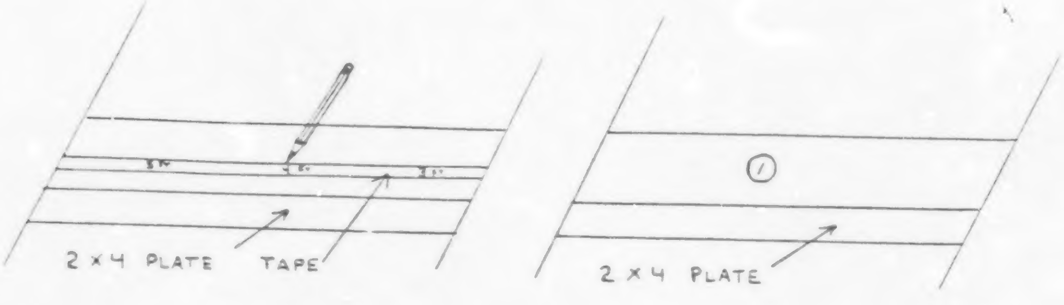

2 x 4 PLATE
TAPE
①
2 x 4 PLATE

Figure 6.

d. Use the combination square to square off a line across the 2 x 4 through the center line. Mark a ℄ over the line (see Figure 7). The ℄ mark stands for "center line".

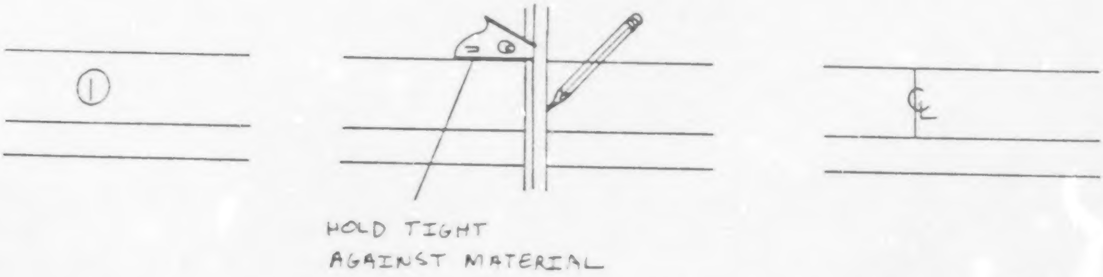

①
HOLD TIGHT
AGAINST MATERIAL
℄

Figure 7.

STEP 3. Mark the rough openings (R.O.) from the center line mark.

Here's how:

a. Look at the Working Drawing for the size of the R.O.

NOTE: Center lines are a popular and convenient way of making the exact middle of a door, wall, etc. To find out where each side of a door or other opening is, find the ℄ (center line) mark. Then measure out from the ℄ to a distance of one-half of the R.O.

b. Determine what one-half of R.O. equals.

R.O. = 3' - 4"
(3' = 36")
R.O. = 36" + 4"
R.O. = 40"

One-half of R.O. = $\frac{1}{2}$ of 40"

$$\frac{1}{2} \times 40''$$

$$\frac{1}{2} \times \frac{40''}{1}$$

$$\frac{1}{2} \times \frac{40''}{1} = \frac{40''}{2}$$

$$\frac{40''}{2} = 2\overline{)\,40''}$$

$$\begin{array}{r} 20'' \\ 2\overline{)\,40''} \end{array} = 20''$$

One half of R.O. = 20"

c. With the tape, hold the one-half of R.O. dimension over the mark of the 2 x 4 plate (see Figure 8).

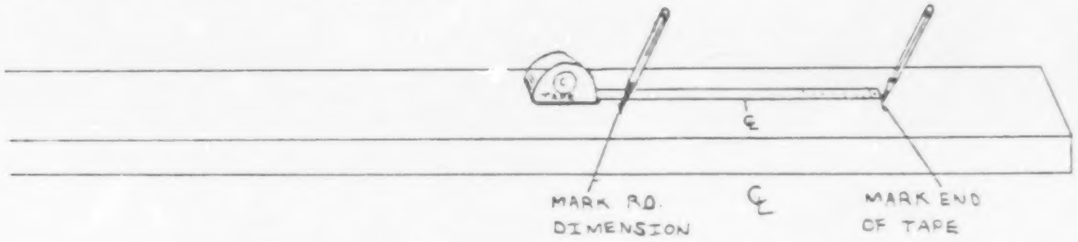


Figure 8.

d. Square across both lines with a combination square.

e. Write the intended use of the R.O. on the plate. (I.E. DOOR, WINDOW, PARTITION as in Figure 9).

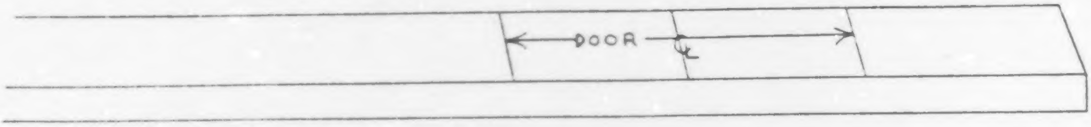


Figure 9.

f. Measure from each end of the R.O. line an additional 1 1/2". Mark for the trimmer stud with a "T" (see Figure 10).

NOTE: The trimmer is a stud that holds up the header (see the Working Drawing).

g. Measure an additional 1 1/2" from the trimmer stud. Mark an "X" for a full length stud (see Figure 10).

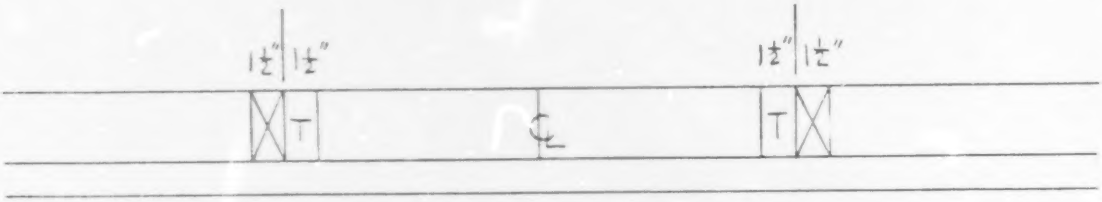


Figure 10.

STEP 4. Lay out for intersecting partitions.

Here's how:

a. Measure from the end of the plate to the location of intersecting partitions (see Working Drawings). Mark as in STEP 2a, b and d.

NOTE: Rough opening (R.O.) is not given for an intersecting partition. Use the width of intersecting plates.

EXAMPLE: If the intersecting plate equals 3 1/2", one-half of 3 1/2" = 1 3/4".

b. Hold one-half of the intersecting plate on the center line. Mark the end of the tape. Mark the intersecting plate dimension.

c. Put 1 1/2" marks on both ends of the lines just drawn. Then place an "X" in the space (see Figure 11).

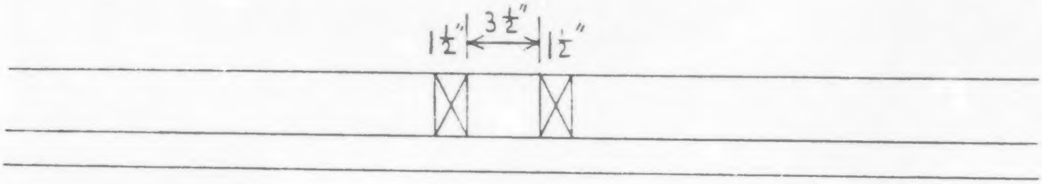


Figure 11.

d. Mark a pencil line 1 1/2" in on the side of the 2 x 4, between the two "X" marks just made (see Figure 12).

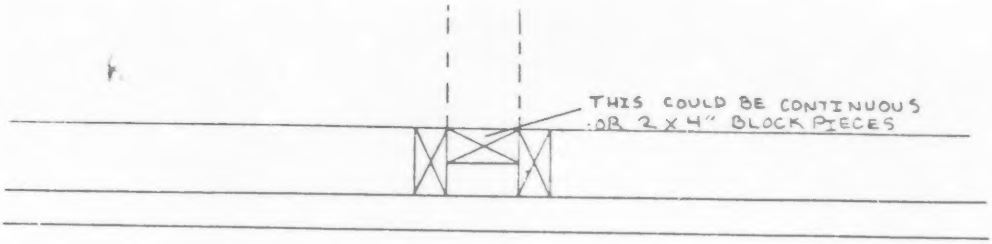

THIS COULD BE CONTINUOUS OR 2 X 4" BLOCK PIECES

Figure 12.

STEP 5. Lay out for a window.

Here's how:

a. Follow STEPS 2a, b and d.

b. Follow STEP 3a.

c. Determine what one-half of R.O. equals.

R.O. = 2' - 0"
(2' - 0" = 24")

R.O. = 24"

$$\text{One-half R.O.} = \frac{1}{2} \text{ of R.O.}$$

$$= \frac{1}{2} \times \text{R.O.}$$

$$= \frac{1}{2} \times 24''$$

$$= \frac{1}{2} \times \frac{24''}{1}$$

$$= \frac{1}{2} \times \frac{24''}{1} = \frac{24''}{2}$$

$$2\overline{\big)\,24''} \quad = \quad \begin{array}{r} 12 \\ 2\overline{\big)\,24} \\ \underline{2} \\ 0 \end{array}$$

d. Follow STEP 3c, d, e and f but this time use 12' 8" as dimension for center line.

STEP 6. Lay out for regular studs and cripple studs' location.

NOTE: "16 O.C." means "sixteen inch on center". "Sixteen inch on center" means the studs are placed 16" apart from the center of one stud to the center of the next stud.

Here's how:

a. Hook tape over end of 2 x 4 and open it until it reaches the other end of the plate (see Figure 13).

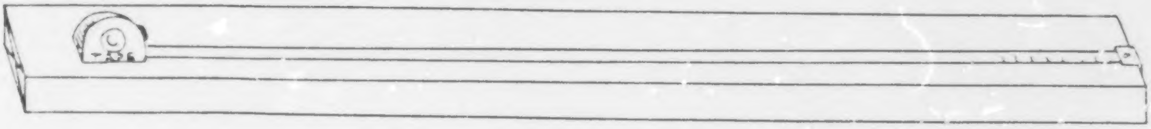


Figure 13.

b. Mark 3/4" less than the 16" mark. For example:

$$16'' - \frac{3''}{4} = 15\frac{1''}{4}$$

$$80 - \frac{3''}{4} = 79\frac{1''}{4}$$

c. Mark each increment with a small "x" and a line, like this: x1 (see Figure 14).

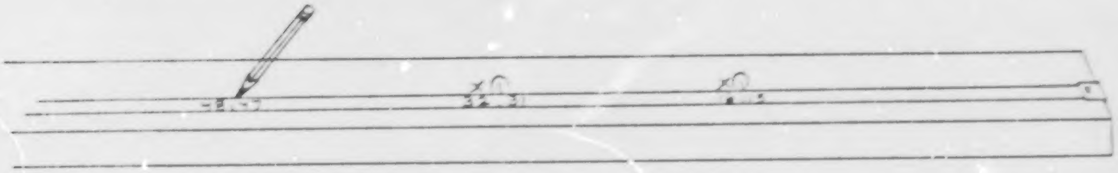


Figure 14.

STEP 7. Mark cripple studs' location.

NOTE: When a "x1" stud mark is on a door or window opening, it is called a cripple stud.

Here's how.

a. Use a combination square to mark a square line through the lay out line.

b. Mark cripple studs with a "C" not an "X" (see Figure 15).

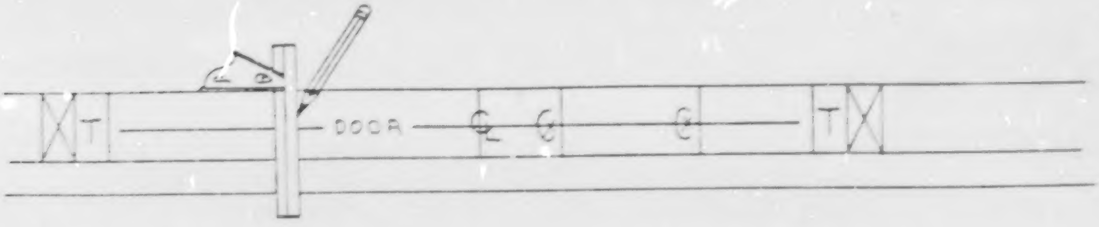


Figure 15.

STEP 8. Mark the "regular studs" (not cripple studs) location.

Here's how:

a. Mark a square line over the small stud location line.

b. Mark a large "X" over the small "x".

STEP 9. Copy all marks on to the top plate.

Here's how:

Hold the top plate (16' long 2 x 4) next to the bottom plate (plate just combined in STEP 9 and transfer all the marks from the bottom plate to the top plate (see Figure 16).

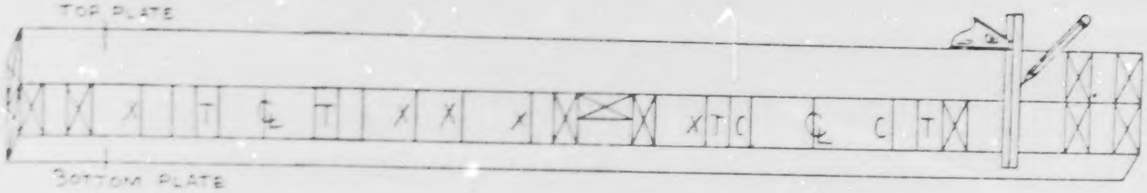


Figure 16.

Performance Criteria

CAG 860 E1: Lay-out Plates and Rough Openings on Exterior Walls

Directions: At this time, check your skills doing these tasks.

1. Lay out and mark centerposts and mark center lines.
2. Lay out and mark rough openings.
3. Lay out and mark intersecting partitions.
4. Lay out and mark windows.
5. Lay out and mark studs.
6. Lay out and mark cripple stud locations.
7. Place marks on the plates (top and bottom) to ± 1/8" accuracy.

If you have questions about any of these skills, you should see your instructor for help. If you feel you can do each skill, then ask your instructor to check your performance using the Performance Checklist for this CAG.

MODULE 6
INDEPENDENT MODULE DEVELOPMENT

ATR GUIDEBOOK

Independent Module Development

Each "learning package" contains:

- A description of what is to be learned;
- Instructions to guide trainees through the learning process; and
- Appropriate materials to use during the learning process.

Effective learning is answered by:

- Providing a wide variety of learning resources and materials, such as books, media, and hands-on practice;
- Providing materials that can be used at the student's own pace;
- Providing structure to the learning process;
- Organizing the learning by tasks;
- Providing continuity -- when the instructor leaves, the training program remains; and
- Including built-in checkpoints for assessing trainee progress.

Types of modules:

- The Trainee direction sheet;
- The learning guide; and
- The self-contained learning package or "module."

Module Development

Competency area:

Title of Module:

Objectives:

What you need:

What you will do:

How well:

Purpose:

Materials and Equipment:

Steps in the Process:
(Use as many as needed)

1.

2.

3.

4.

5.

Here is How:

1.

2.

3.

4.

5.

Performance Criteria:

1.

2.

3.

4.

5.

6.

7.

8.

MODULE 7
COMPUTER-BASED TRAINING

REFERENCE MATERIALS

Computer-Based Training

CBT is defined as using a computer to train an individual for a specific duty, task, or skill. Even though it is a fairly new concept, enough data have been collected to conclude that this is a worthwhile training approach. Often a trainee will learn more in the same amount of time than a trainee using the traditional method of instruction. A well designed CBT course can teach the same amount of information in a shorter time than a traditional training program.

CBT is not designed to replace the instructor, rather it changes the role of the instructor. Instead of servicing as a source of information, the instructor becomes a facilitator, assisting the trainee to solve a particular problem.

Because CBT is new, much needs to be learned about using this method of training. For example, can the continued use of a cathode ray tube (CRT) be a health hazard? Furthermore, for optimal learning, how many hours a day should a trainee be assigned to use a terminal?

In addition, the initial expense of installing a CBT system can be high. Each need is different. Start-up hardware costs for computers can range from $5,000 for a one person work station to $11,000,000 for a large mainframe designed to service hundreds of trainees. Peripherals such as a printer can cost from $180 to $315,000.

These prices do not necessarily include programming costs. Existing courseware is cheaper than newly developed courseware created for a special need.

CBT system costs must be compared to the costs of the traditional training system it is replacing. Before saying that CBT is too expensive, a complete cost analysis must be done. Time spent in training and the effectiveness and efficiency demonstrated on the job are but some of the factors which should be considered. What follows are three examples of CBT systems.

PLATO

PLATO is a widely used CBT system, which is available in two versions. One version is a system where multiple terminals are connected to a large central computer. The other is a free-standing system which uses flexible disks to store instructional programs. The disks are inserted into disk drives.

Training material appears on a video display terminal in the form of text, drawings, and animated graphics. The trainee responds either by touching the screen at an indicated place or by typing in the correct answer on the keyboard.

PLATO currently has more than 8,000 hours of courseware on a variety of subjects. Much of this courseware is available for use on non-PLATO type microcomputers. Control Data Corporation, maker of PLATO, is continuously developing new courseware both for general consumption and in response to specific requests.

MICROTICCIT

A second example of a hardware/courseware system available is Micro Ticcit (MT). Developed by Hazeltine, MT can utilize both off-the-shelf and personalized courseware.

MT has a number of capabilities. These include:

- Color graphics;
- Light pen/touch panel screen:
- An audio system;
- An optional videodisc player;
- A graphics utilizing camera which can scan complex drawings and photographs directly into the data base; and
- A standard IBM PC microcomputer which can use any standard software.

FRANKLIN HAND-HELD TUTOR

Not all CBT has to be done on large systems. Weighing less than four pounds and measuring 9"x11" the Hand Held Tutor developed by Franklin Research Center will cost approximately $150 when production starts. This price does not include courseware.

The original application of the Tutor was to drill soldiers on the vocabulary words specific to the requirements of a cannon crewman. It can be adapted easily to the needs of industry. Changing from one curriculum to another is accomplished by switching a plug-in module. The courseware designed for the Tutor can take advantage of an instructional booklet, speech capability, and a small viewing screen.

SIMULATORS

Simulator training also uses computers. In simulator training, the trainee is put on a device designed to react similarly to the actual piece of equipment. Only after certain skills are mastered is the trainee allowed to practice on the actual piece of equipment.

There are many advantages to using a simulator including:

- They often are cheaper to build than the actual equipment;
- The cost of making a mistake is reduced;
- There is immediate feedback on an action;
- Crises and emergencies can be simulated without endangering the trainee;
- The level of difficulty can be altered depending upon the trainee;
- Sequences of a task can be varied depending upon the trainee's needs; and
- Time can be compressed allowing for a full sequence of actions to take place.

There also are disadvantages. These are:

- High cost of developing a good simulator;
- Lack of faith in simulator training as expressed by many training instructors; and
- Lack of a thorough understanding relating to the transferability of skills learned on a simulator.

INTERACTIVE VIDEODISC LEARNING SYSTEMS

Interactive videodisc learning systems have been called "the ultimate educational tool." These systems combine the technologies of television and computers to create a learning device that allows the user to interact with the course material being presented on the screen.

Hardware for this system includes a TV or monitor, a microcomputer, a light pen, a videodisc player and an interface device used to transmit commands from the microcomputer to the videodisc player. The actual course or program is recorded on a videodisc, similar in size and appearance to a record.

The system's interactive capabilities allow for simulations as discussed previously. Also, a process called branching is used, whereby the trainee can take a series of alternative routes through the course materials.

This system has been applied to the video game market as well as to industrial and military training.

Information Sources for Computer-based Training

CEVUE Video Information System
C-E Power Systems
Combustion Engineering Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Computer-Based Training
U.S. Army Research Institute
for Behavioral and Social Sciences
5001 Eisenhower Ave.
Arlington, VA 22333

Computer-Based Training Systems
McDonnell Douglas Astronautics Company
Suite 124
1390 South Potomac St.
Aurora, CO 80012

Control Data Corporation
P.O. Box 0/HQA02I
ATTN: PLATO Inquiry Control
Minneapolis, MN 55440

DeltaVision Training System
East-West Technological Center
1751 Diehl Road
Naperville, Illinois 60566

Hand-Held Tutor
The Electrical Engineering Department
Franklin Research Center
20th and Race Streets
Philadelphia, PA 19103

Interactive Videodisc Technology
Human Resources Research Organization
300 North Washington St.
Alexandria, VA 22314

Interactive Training Systems
4 Cambridge Center
Cambridge, MA 02142

MicroTICCIT
Hazeltine Corporation
7680 Old Springhouse Road
McLean, VA 22102

Nebraska Video Disc Design/Production Group
P.O. Box 83111
Lincoln, NE 68501

Singer Aerospace and Marine Systems
Link Flight Simulation Division
Binghamton, NY 13902

Sony Videodisc Systems
9 West 57th Street
New York, NY 10017

MODULE 7
COMPUTER-BASED TRAINING

ATR GUIDEBOOK

Why is Computer-based Training Effective?

- Courseware is written to allow the trainee to proceed in an individualized and self-paced manner;
- Trainees are allowed to make errors without fear of embarrassment;
- Positive reinforcement is immediately provided;
- It is cost-effective;
- There is increased time on task; and
- Consistent instruction is delivered from site to site.

Glossary

Fidelity - The degree of similarity, both physical and functional, between a training device and the actual equipment for which the training was undertaken.

Individualized Instruction - Learner-centered instruction in which the materials and activities are tailored to meet the needs of the individual student.

Job Analysis - Describing a job in terms of the tasks involved in that occupation.

Job - The composite of duties and tasks performed regularly in one's trade, occupation, or profession.

Multimedia Instruction - Instruction using different pieces of hardware and courseware, e.g., video tapes, tape recorders, film, books, etc.

Simulator - A computer driven device designed to react similar to an actual piece of equipment.

Task - A measurable element of work usually performed by a single worker in a short span of time.

Videodisc - Similar in appearance to a record; it is used to store visual images and audio which can be recalled on demand.

UNIT C
MARKETING APPRENTICESHIPS

MODULE 8
MARKETING PLANNING

REFERENCE MATERIALS

Marketing Planning

Marketing means finding out who would be interested in your products or services, explaining what you provide, and convincing prospects that they need what you are offering. Because you are striving to improve our national workforce, your measure of success in marketing will be weighed in the number and quality of apprenticeship programs American industry installs and maintains in its plants and training centers each year.

WHY USE A MARKETING CAMPAIGN?

Organizing By Objectives

Marketing campaigns help you determine and accomplish specific objectives and enable you to break down into manageable parts your overall purpose in marketing. A good marketing campaign will help you delineate the benefits of what you are promoting, pinpoint the prospect's needs, and match the two in a systematic way.

Assessing "The Product"

Marketing studies show that people "buy" benefits, not products or services. As an ATR, you are promoting the benefits the employer will derive from installing or expanding apprenticeship training. The attributes of apprenticeship training include: thorough skill acquisition, quality assurance points, benchmarks, and standards. Among the benefits of apprenticeship is a workforce that is better trained, motivated, and productive.

Attributes of performance-based apprenticeship include: self-paced instruction, criterion-referenced testing, and measurable tasks. Its benefits include accountability and efficiency.

As ATRs, you are also promoting registration of existing apprenticeship programs. Among its attributes: technical assistance from the BAT and the state, quality monitoring, technical materials, and certification. Its numerous benefits include publicity, solutions to problems, and access to resources you might not otherwise have.

If a prospect has no training program, you are chiefly selling the general benefits of training plus the more specific benefits of apprenticeship, and the added benefits of registration. If a training program exists, you must concentrate on how to improve it.

Anticipating Objections

Another reason for a well planned marketing campaign is to enable you to anticipate objections ahead of your prospect, so you are prepared to counter them. A good marketing campaign ensures that every possible negative has a positive answer, which is backed up with examples or statistics.

Assessing "The Prospect"

A good marketing campaign also enables you to "systematically" assess the prospect. This is one of the most important tasks in marketing, ensures that you are making your pitch at the right time, to the right people, at quality assurance points, benchmarks, and standards. Among the benefits of apprenticeship are a workforce that is better trained, motivated, and productive.

Attributes of performance-based apprenticeship include: self paced instruction, criterion referenced testing and measurable tasks. Its benefits include accountability and efficiency.

As ATRs, you are also promoting registration of existing apprenticeship programs. Among its attributes technical assistance from the BAT and the state, quality monitoring, technical materials, and certification. Its numerous benefits include publicity, solutions to problems, and access to resources you might not otherwise have.

If a prospect has no training program, you are chiefly selling the general benefits of training plus the more specific benefits of apprenticeship, and the added benefits of registration. If a training program exists, you must concentrate on how to improve it.

Tailoring Benefits

The campaign also enables you to match the benefits of the service with the specific characteristics and needs of the company to which you are marketing. The tailoring aspect of a marketing campaign pinpoints specific needs and necessitates scenarios for dealing with them.

MARKETER CHARACTERISTICS

Credibility

The prospect will assess your credibility in terms of: knowledge of training, apprenticeships. his or her industry, company, needs; knowledge of specific training techniques, and knowledge of business practices and costs. Credibility is most greatly enhanced by demonstrating a clear grasp of information. Cite examples, use statistics, be as specific as possible with the information you have.

Alertness

Alertness enables you to pick up on points that the prospect may not have known he was revealing.

Flexibility

Flexibility enables you to change your course of action when new information appears, to alter costs, schedules, approaches, prospects, training delivery time, and so on.

Persistence

Persistence means showing determination to "gatekeepers," who screen calls. Become familiar with gatekeepers by calling often, sending notes, and making youself known.

Do not create a negative image of yourself or the BAT or invite hostility by pestering people. Keep all contacts brief and businesslike.

Thoroughness

Thoroughness means seeking out any and all information to use with a prospect. Investigate and describe other sponsors' apprenticeship programs, noting many useful aspects, such as the profitability and productivity measures that were taken. Supply substantive information the prospect can use.

Empathy/Trustworthiness

Empathy and trustworthiness mean avoiding a "standard" approach to every marketing task. Ask what would help the prospect to do the job better and succeed in the company. Ask how this could also promote apprenticeships. If apprenticeship is inappropriate, acknowledge this openly and plan to move on.

Courtesy

Courtesy extends to arriving on time, keeping up with the prospect's schedule, listening to suggestions, and keeping your visit brief and to the point.

MARKETING PLANS

Marketing requires a continuous gathering and honing of information that becomes more and more specific and directed as you apply what you know. The following techniques are useful in marketing campaigns.

Researching

Researching provides background about companies that focuses your search. Balance research with spontaneous reports from direct personal contact with the central marketing targets.

Informal research means making contacts, calling on people, and getting a feel for a situation. Formal research means getting statistics and formulas, making graphs, and obtaining specific data.

Assessing Targets

To determine the marketing climate, and which companies are likely to be receptive to you as a BAT training "consultant" and to BAT support, analyze the companies in terms of several factors:

- **Products/Services** - What is produced, and how? Could better training improve the product or service?
- **Types of Employees** - What types of skilled employees work there? What percentage are craftsmen/journeymen? How are journeymen recruited or trained now?
- **Management** - Who makes the policy decisions? What policy issues are in effect, such as a training policy or philosophy? What impact will training have on policies and vice versa?
- **Business Outlook** - How is the company financially? Competitively? Would better trained employees improve the outlook? How?
- **Employment Practices** - How are raises and promotions justified? Are employment practices perceived as fair and helpful to employees? How is general morale? How could training improve conditions?
- **Union Activity** - How are unions involved with training? How do employees/managers perceive the union's impact in this area?

- **Government** What government-sponsored programs are now in effect? Have others contacted the company about apprenticeship? Who responded and how?

- **Training** What kind of training exists? How effective is it? How could performance-based or other apprenticeship improve it? If apprenticeships exist, are they registered? Why not?

Answering these questions provides an approximation of a company's needs. The answers also tell you whether they are prospects that show growth or change potential, have labor shortages, and are capable of sustaining apprenticeships.

Tailoring Benefits to Needs

To persuade a company to install or expand or register an apprenticeship, convince them that the BAT's services will benefit them. Match, or tailor, the specific needs you've found in the companies with the benefits you've identified. Note that benefits differ according to whether you are encouraging the prospect to switch to apprenticeship, to install an apprenticeship program where nothing exists, or to register an existing apprenticeship program.

Establishing Files

Keep marketing information organized by establishing a separate file for each target company. Keep all client information together, and maintain a log of each telephone and personal call you make in developing this prospect. Keep the files orderly so you can find information as you need it for appropriate, timely follow ups. Review the file before making each call or searching for new published information.

Briefing

Before you approach the target, prepare yourself thoroughly. Make a list of what you want to accomplish at this meeting and at subsequent meetings. Prepare to highlight benefits and overcome objections the prospect may have with a list of solutions.

"Selling" an apprenticeship program is a gradual process that proceeds from establishing rapport to gaining a commitment for specific action. This will take several meetings.

Call to make an appointment for your initial meeting. Attempt to establish rapport and credibility and to gain some basic facts about needs.

Limit the initial meeting's objectives to establishing what BAT does and how well, who you are and how helpful you can be, and setting a general tone for future meetings. Explain what the BAT does nationally and in your jurisdiction, such as cooperating with businesses in the area. Assure the prospect that you are concerned with the company by asking probing questions about company needs. These may be the same questions you asked others about or ones you think you know the answers to already. Be sure to get the prospect to identify basic needs. Also ask the prospect what training aspects he or she considers most important and ask questions about how to train.

Many marketers believe that whoever talks first loses. In an initial meeting, do not offer plans to solve a specific need. Push the questioning back to the prospect. Use the meeting to probe for aditional problems you might help solve later.

Collect whatever information you need and ask for names of additional people to contact, if necessary. Start to end the meeting once you've met your objectives. Arrange for subsequent meetings.

Provide copies of promotional training and BAT literature, invite the prospect to call you, and leave your phone number and address. Follow up with a letter thanking the prospective sponsor for the opportunity to meet and confirm the schedule for future meetings. Write a brief summary of the first meeting, file it, and review it before making future contacts there.

Closing

To obtain a sponsor's commitment, establish the following:

- Openly identify the prospect's needs;
- Highlight the particular benefits to the company; and
- Overcome objections.

Openly Identifying Needs. Ask the prospect to state the company's needs to you. Write them down. Restate them and have the prospect agree to the identified needs.Clarifying needs targets your benefits plan. If you don't understand or are surprised by the stated needs, ask more questions. Try to surmise why the stated needs are different from what you had assumed.

If you think the company has needs they don't know about, bring them up. Also find out if someone else is responsible for meeting these needs. If so, see who it is and get that person and your prospect together. Get them to agree on the needs and to state them to you. Merging needs will help you get the broadest all-around commitment from the company.

Highlighting Benefits. After the prospect has stated the needs, highlight how establishing an apprenticeship program can meet them. Explain with examples that highlight general benefits, statistics showing cost-savings, documentation of morale-building, and so on. Obtain a testimonial from someone in industry with an apprenticeship program similar to the one you are promoting.

At a minimum, a marketer should be able to speak convincingly about the following apprenticeship benefits:

- **Saves Money.** Monetary savings through reduced waste, increased efficiency;
- **Skills Shortages.** Filled through resupply of aging, changing labor force;
- **Quality of Journeymen.** Improved through experienced teachers training others;
- **Job Relatedness.** Assured through on-the-job learning;
- **Competitive Position.** Enhanced through better journeymen;
- **Employee Morale.** Improved through increased skills;
- **Supervision.** Decreased through better skilled journeymen;
- **Work Force.** Stabilized through better journeymen;
- **Supply of Supervisors.** Built through foremen training apprentices; and
- **Screening Criteria.** Provided through training standards.

Marketers must also be able to highlight the following benefits of registering apprenticeships:

- **Provides Technical Assistance;**
- **Assures Standards;**
- **Enables Recordkeeping;**
- **Provides Prestige;**
- **Provides Certificates;**
- **Provides Government Liaison; and**
- **Provides Facilities.**

Overcoming Objections. Overcoming objections means minimizing the problems, or turning problems into benefits. Anticipate what they may be and prepare appropriate responses. Objections may include the following:

- **Cost.** Turn this negative into a positive by citing the many cost-saving programs in which the apprentices actually save money for the company. Cite the long-term investments in training.
- **Bureaucratic.** Explain how you will guide their efforts, helping with the paperwork, and cutting "red tape."
- **EEO.** Explain that employment practices are already subject to EEO laws, which you can help them comply with.
- **Unnecessary.** Ask prospects to assess the average age of their journeymen, upcoming retirements, and planned replacements.

- **Time Consuming.** Explain that a time investment in training pays off in the long run by reducing workers' mistakes, boosting employee morale, and reducing time-wasting lethargy.

- **Non-flexible.** Show examples of apprenticeships tailored to individual companies and high tech skill programs. Explain that BAT's goal is to help improve the skills in American industry, not stymie a company's progress.

- **Standards Wrong.** Explain to prospects that, although standards are set, joint apprenticeship training committes will work with the company to determine the best skill training for their apprentices.

- **Size.** Explain that any and all programs qualify for government input and that their program may expand with BAT technical assistance.

Commitment. One you have openly identified the prospect's needs, highlighted the particular benefits of apprenticeship, and overcome any objections, ask for a commitment to your suggestions. A commitment requires the prospect to first internalize your ideas and "buy" them as his or her own and to "sell" these ideas to others in the company. In closing, keep your speech short, maintain silence, listen for an answer. If the final response to your selling is negative, treat it as another objection and return to a tactic for overcoming it. Do this until the prospect says yes or until you know for sure he or she will not agree.

Once the prospect "buys" apprenticeship, he or she markets the particular plan to others in the company to get their cooperation. Describe the personnel the company will need, the equipment, facility, money, and time. Explain what resources the BAT will provide. Make up budgets, timetables, performance measuring devices, and so on.

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MODULE 8
MARKETING PLANNING

EXERCISE MATERIALS

Vignette 1
Credibility

(Friendly, Inquisitive)

PROSPECT: So, you've been working for the Bureau for a long time, huh?

(Perkily)

MARKETER: 15 years. Yeah, I can't believe it myself.

(Friendly, Inquisitive)

PROSPECT: That is a long time. I guess you've seen a lot of changes. It's tough keeping up with the training changes in our industry.

(Absently)

MARKETER: Well, it's not as hard as you'd think. Excuse me. I mean, people gotta do their jobs, companies've gotta train 'em. Whether they work with pencils, rivets, bricks... it's all pretty much the same in training.

(Getting Skeptical)

PROSPECT: Hmmm. Well, that's not true here at Xanadu Electronics. We've had major changes in the way we've worked over the past 10, even 5 years. Of course you're familiar with our laser particle separation process.

(Lamely)

MARKETER: Well, er... not really.

(Proudly)

PROSPECT: It made the cover of Business Week twice. We were also featured on "60 Minutes," which I'm sure you know. The President even mentioned the process at a press conference. He said our methods signalled a turning point for American industry.

(Muttering)

MARKETER: Mm... I guess... vaguely familiar...

(Surprised and Annoyed)

PROSPECT: You're kidding. Well, tell me, has the B-A-T started any apprenticeships in a company like ours?

(Vaguely)

MARKETER: Oh, oh, yes, of course, I'm sure.

(Sarcastically)

PROSPECT: So... enlighten me. How did they work?

(Outwardly Annoyed)

PROSPECT: Certainly, you're able to give me a few facts about them.

(Brightening)

MARKETER: Oh, sure. Uh, for instance, we set up a great carpentry apprenticeship. Those kids sawed and banged their little hearts out.

(Very Annoyed)

PROSPECT: (Sighs.) Couldn't we stick to the electronics industry?

(Disappointed, Floundering)

MARKETER: Sure, but I don't know that much... I mean we've done 'em but... you see... well...

(Energetically, Polite)

PROSPECT: (Snaps fingers.) Oh no, Mr. Bungler, I have another pressing appointment. I do hope you'll excuse me. Please leave the door open on your way out.

Vignette 2
Alertness/Flexibility

(Phones Ringing, Typewriters Clacking In Background)

PROSPECT: Have a seat, Mr. Mayhue, or may I call you Bill?

MARKETER: Sure, Bill's fine. I'm delighted you could see me today after all. I appreciate how busy you are.

PROSPECT: Well, it's always like this in the semi-conductor 'biz. So, I understand you want to talk "apprenticeships."

MARKETER: Yes, I'd like to explain how apprenticeship can benefit a company like yours. Most of all, I'd like to hear about some of your specific needs here at Benetar.

PROSPECT: To be honest, I personally don't like the idea of apprenticeships. I know the company doesn't, and, in any case, we don't really want the government involved.

MARKETER: Well, (laughs) maybe I should tell you more about apprenticeship in general, to see if we're talking about the same thing.

PROSPECT: O.K., shoot.

(Knock On Door)

PROSPECT: Excuse me, please. Yes?

CO-WORKER: Oh, sorry to interrupt you, John, I didn't know you had a guest. However, we do have a, er, "situation" downstairs in production and I think you should know about it. (Ahem), maybe we could step outside for a moment?

PROSPECT: Oh, you can talk in front of him. He's a Fed, not an industrial spy. What's the problem?

CO-WORKER: Well, O.K. Ogilvy just fired three more linesmen this week because they made consistently poor welds that crippled the 4A transporters. They were supposed to ship those transporters by Friday!

PROSPECT: Jeez! Where do we keep getting these people?

CO-WORKER: I don't know, but this cannot go on. I suggest we pay linesmen more and finally get some really reliable people. Anyway, this isn't the time to discuss it.

PROSPECT: Allright, Margaret. Let's discuss it this afternoon, as soon as Mr. Mayhue leaves.

CO-WORKER: O.K. I'll temporarily switch the other crew over to the line to take over for this month.

PROSPECT: Good idea.... and thanks.

CO-WORKER: That's O.K. (Door clicks closed.)

PROSPECT: Now what were we saying?

MARKETER: Actually, Mr. Kaiser, maybe we could discuss registered apprenticeships. I think you'll see that the very exacting skill standards for apprentices are just what your company needs. For example you could eliminate the problem you now have....

Vignette 3

Persistence/Thoroughness

MARKETER: Hello, Ms. Vaughn. I stopped by on my way into town. Is Ms. Reynolds in?

GATEKEEPER: Sorry, she's out all week.

MARKETER: Well, could I see her assistant? I'm still pushing apprenticeship and I know this company will be interested.

GATEKEEPER: I'm afraid he's out, too. A big meeting in Denver for training. In fact, everyone in this department is being trained, except for the skeleton crew.

MARKETER: In that case, could I see whoever is taking over for Ms. Reynolds?

GATEKEEPER: I doubt if it'll help, but I'll buzz him. (click). Just a second John, Mr. Carnegie is here from the Bureau of Apprenticeship and Training. He wants to talk about apprenticeship. Uhm hum, O.K. (click) He says to go in. He's very busy but he heard about you hanging around and he is curious.

MARKETER: O.K., thanks.
(Door opens and shuts)
Hi, I'm Allen Carnegie, Bureau of Apprenticeship and Training.

PROSPECT: John Michaelson. I understand you've been here so often that our receptionist should get hardship pay.

MARKETER: Not really *that* much, but I'm glad I *finally* got to meet with someone.

PROSPECT: Yeah, it's sometimes tough getting through. And everyone's so busy, they screen the visitors very carefully.

MARKETER: Mr. Michaelson, I want to let you know that I'm not here to sell anything, just to talk about apprenticeship.

PROSPECT: Allright.

MARKETER: You know, it struck me, that sending everyone out to Denver must be expensive.

PROSPECT: It is, but we've gotta keep people abreast of technology.

MARKETER: True. But if you had an apprenticeship program this situation wouldn't have to happen.

PROSPECT: Why not? People always have to update their information.

MARKETER: Right. But in apprenticeship training, we are very careful to provide the latest information and techniques. Excuse the cliche, but apprenticeships must be "state of the art." And this constant updating of information spills over to all employees. It can raise the general level of information at an entire company.

PROSPECT: Sounds interesting. You know, I'm glad you hung in there. Keep talking. We might be on to something.

Vignette 4
Empathy/Trustworthiness/Courtesy

PROSPECT: Katheryn, have you seen that man from the Labor Department yet?

SECRETARY: No sir. He was supposed to be here at 10.

PROSPECT: I know. And look, it's 10:20. No call, no person. What does he think, that I've got all day to wait for him?

SECRETARY: Oh, look, I see him coming down the hall.

MARKETER: Excuse me, Ms. Oh, and Mr. Santos, Hi. Sorry I'm late, I, 'er, got held up in traffic.

PROSPECT: (Mm) Allright. Did you bring those cost-benefit plans we discussed last week?

MARKETER: Oh Jeez! I forgot! Could you wait 'til we meet next time? I'll bring them then.

PROSPECT: That's just fine! I arranged to meet with the training director today, and I told him your ideas were solid. Even told him I'd already seen the cost-benefit figures you'd drawn up for our company.

MARKETER: I'm sorry, I'm very sorry. I've been so busy lately. We're in a full press, marketing apprenticeship. I guess this one just slipped my mind.

PROSPECT: Sure. Well I'm sorry your other plans intervened. I just can't see how we can go forward on this. I think you blew it for the B-A-T.

Marketing Exercise

Your BAT supervisor believes the Bureau has not sufficiently tapped the companies in your jurisdiction as potential sponsors. You have been asked to target systematically 10 such prospects and to make phone calls and face-to-face promotional contacts with them.

To determine which companies may be most receptive to BAT efforts, you use several criteria to assess the companies. You report to your supervisor with information about those companies in your jurisdictional area that are growing and have a need for highly skilled workers. Out of the 10 prospects you've researched and reported on, one seems especially in need of BAT services. The Byron Manufacturing Company, a robot manufacturer.

The Byron Manufacturing Company has more business than it can handle with its current employee level. The plant already operates two full shifts, but the firm is falling behind on its delivery schedule. Customers are threatening to take their business elsewhere if Byron can't maintain a timely delivery schedule.

Most of Byron's employees came to the firm after being laid off from jobs with other manufacturers. Byron re-trained them in-house, with some assistance from a local community college. The average age of Byron's employees is 47.

Despite the success of their in-house re-training effort, Byron's recently hired vice-president for production is against training new employees. He has also stated that government programs take too much time, cost too much, and involve too much red tape.

One of your contacts at Byron has told you that the company is about to sub-contract some of its workload to other vendors. It hopes this will be a stop-gap measure, used until it can determine what to do about long-term staffing needs.

Your supervisor would like you to prepare a marketing plan for how you will approach Byron regarding its training needs. Use the following forms to help you plan your approach.

First complete Planning Format A, listing apprenticeship attributes and benefits and relating them to the known needs of Byron Manufacturing. Then proceed with your marketing plan on Format B. You should base this plan on your knowledge of Byron; however, when necessary, you can make additional assumptions about the company and the jurisdiction. Format B has three sections; research, briefing, and follow-up. Complete all three and be prepared to discuss the results with the other participants.

Apprenticeship and the Byron Manufacturing Company

Planning Format A

Objective: ______________________________

____

____

____

Apprenticeship Attributes	Apprenticeship Benefits	How This Can Help Byron Manufacturer

Marketing Plan for Byron Manufacturing

1. RESEARCH

Research Sources and Actions: ______________________________

Initial Contact: ______________________

Follow-up Contacts: ______________________

Anticipated Objections	**Proposed Solutions**

2. BRIEFING

Attendees:

Promotional materials (a.v. or printed):

Objectives:

Closing:

3. FOLLOW-UP:

Additional contacts:

Additional research: ______________________________________

____

____

____

Information/Technical Assistance requested by Byron: ____________

____

____

____

MODULE 8
MARKETING PLANNING

ATR GUIDEBOOK

Marketer Characteristics

- Credibility
- Alertness
- Flexibility
- Persistence
- Thoroughness
- Empathy/Trustworthiness
- Courtesy

Marketing Campaign

- Organize by objectives
- Assess "the product"
  (the benefits of apprenticeship)
- Anticipate objections
- Assess "the prospect"
- Tailor the benefits

Marketing Plans

- Research--formal and informal
- Assess the target
- Tailor benefits to needs
- Establish files
- Conduct briefing
  - identify needs
  - highlight benefits
  - overcome objections
  - obtain commitment

Marketing Analysis

Company ______________________________ ______________________________
name address

Contact ______________________________ ______________________________
name title phone #

Total employees ______________

Major Products/Services ____

____

____

____

Types of Employees

Skilled	Unskilled
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________
______________________	______________________

% Craftmen/Journeymen__________

DECISIONMAKERS

Name	Title	Reports to

Current Training Policy

Does a policy exist? ____ yes ____ no

If yes, what is the policy? ____________________

____

____

____

Is there a Training Department? ____ yes ____ no

If yes, describe the structure, staff, budget, etc. ____________________

____

____

____

____

Business Outlook

Did they make a profit last quarter? ____ yes ____ no

Last year? ____ yes ____ no

Who are their competitors? ______________________________

____

____

Employment Practices

How is morale? Low 1 2 3 4 5 High

Are employees satisfied? Not at all 1 2 3 4 5 Very

Is there a union or other strong employee group? ____ yes ____ no

Employee Group Contact ______________ Phone ______________

Government Programs

Does the company participate in any other government programs? ____ yes ____ no

What are they? ______________________________

____

____

____

Benefits of Apprenticeship

- Saves money
- Fills skills shortages
- Improves quality of journeymen
- On-the-job learning assures job-relatedness
- Enhances competitive position
- Improves employee morale
- Decreases need for supervision
- Stabilizes workforce
- Maintains supply of supervisors
- Provides screening criteria

Benefits of Registration

- Technical Assistance
- Assures Standards
- Recordkeeping
- Prestige
- Certificates
- Government Liaison
- Facilities

MODULE 9
COST/BENEFIT ANALYSIS

REFERENCE MATERIALS

Cost/Benefit Analysis

Cost/benefit analysis is a decisionmaking tool that enables someone to decide to take an action or series of actions based on objective measures. The analysis compares the costs for performing the action against the benefits that will likely occur if the actions are carried out. If the benefits outweigh or exceed the costs, then the action is justified for the decisionmaker.

We all face decisions in our domestic or work lives that are amenable to cost/benefit analysis. Let's look at a few.

CHANGING JOBS

The decision to be made is should I change my job for another one?

You can list the benefits and the costs that you will gain and lose if you change your job. For example, the benefits might include: future opportunity for promotion and salary increases; opportunities for learning new skills; increased employee benefits; less physically demanding or stressful work; and shorter hours.

Some typical costs might include reduced salary or wages; more commuting costs; loss of seniority, and purchase of new clothes, tools, or uniforms. Other possible benefits might be: more marketability; more attractive work location; or opportunities for employer-subsidized education.

Some additional costs might be: loss of time with old work friends; loss of some leisure time to learn new job requirements; or disruption to spouse's job.

In this situation we often hear people say that they weigh the positive gains against the negative consequences and make a decision about whether to change jobs or not. People who do this are really making a cost/benefit analysis. If they feel that a job change will result in a net gain, they are more likely to decide to change.

Let's look back to our costs and benefits for this example. Many of the costs and benefits are clearly quantifiable. That is, we can put a dollar value on them. Gains or losses in salary have a clear cut dollar value as do increased employee benefits and longer commuting distance. The cost of tools, uniforms, and clothes can be reduced to a dollar figure. Some of the other costs and benefits are reduceable to dollars and cents but not so readily. For example, the loss of seniority can be translated into a monetary value; so can the acquisition of new skills that make you a more valuable or marketable employee.

Some of the costs and benefits are less obviously quantifiable. How about the likelihood of less stressful work? If we can relate this benefit to other off-the-job benefits we can put a number on this benefit or gain. Other costs or benefits are much less tangible and not easily costed out. For example, reduced contact with or loss of friends on the job may be very important, even though we can't readily cost this out.

EXAMPLES

Nevertheless, many decisions lend themselves to cost/benefit analysis and can be analyzed into quantifiable costs and benefits. Even the decision of whether to get married or not can be analyzed from the prospect of costs and benefits. Probably most people let the intangibles outweigh the dollars and cents factors in making their decisions.

The following are examples of decisions where cost/benefit analysis is commonly used.

- **Plant Locations.** A company wants to locate a plant. Several sites are under consideration. Each offers different advantages and disadvantages with respect to securing raw materials, marketing the finished product, and locations. The company seeks to maximize profits.

- **Road-Building.** A local or state government proposes to build a toll road. With the road, travelers, consumers, producers, and some landowners will benefit; transporters and other landowners will suffer. Road travel will create air pollution unpleasant to some of those living nearby. The government must weigh these differing factors and decide to build or not to build the road.

- **Inoculation.** A massive inoculation program is planned. It is intended to reduce distress, deaths, and workdays lost due to a particular disease. Not only will those vaccinated benefit but the unvaccinated will also benefit from reduced contagion hazards. There is a slight risk of severe and possible fatal reaction to the shots. The decisionmaker must balance the prospective benefits against the costs to determine whether the program should be enacted.

- **Work-at-Home.** A company is considering supplying personal computers to key middle managers and executives so they can work at home as well as at the office. The likely gains to the company of working at home will be increased productivity, savings in liability insurance, and reduction in office energy costs. Some possible costs, besides the cost of the computers and modems, are energy cost reimbursements for home use, reduced security for proprietary company data, and increased telephone expenses. Other factors that affect the decision relate to employee morale and organizational communications. The chief executive officer wants to make a go or no-go decision.

The foregoing were but a very few examples of the kinds of problems and decisions that lend themselves to cost/benefit analysis. People in business, as well as in government, face decisions every day that can be quantified in this manner. As ATRs, you face members of the business community constantly and their concern is for the bottom line. "What is it going to cost me and what am I going to get out of it?" are questions that arise all the time. In training and apprenticeship, we ought to be prepared to deal with these questions from a cost/benefit perspective.

MODULE 9
COST/BENEFIT ANALYSIS

EXERCISE MATERIALS

The Acme Electronics Company

The Acme Electronics Company designs and fabricates electronics equipment for defense applications. It employs 2,000 people who design and make electronic circuitry from dies and molds. The circuitry is used by an aerospace contractor for use in highly sophisticated weapons systems. A new subcontract with the aerospace firm requires Acme to increase the numbers and types of circuits. This, in turn, requires that Acme either buy or develop increased tool and die capabilities.

Top executives of Acme want the firm to subcontract with tool and die vendors to fabricate the required precision tools and dies. The training director feels that it would be wise if Acme increases its own internal tool and die capability. He suggests that an apprenticeship program be set up. The Vice President for Operations tells the training director that Acme will chose the way that is most effective from a cost standpoint to the firm. He gives the training director two weeks "to develop the numbers."

Working with an ATR, who has been marketing Acme, the training director develops the following data.

OUT OF POCKET COST FOR TRAINING

---

1. Acme will need 70 apprentices, each working 2,000 hours per year -- 140,000 hours.

2. The average hourly wage of the apprentices in the first year will be $9.50.

3. Fringe benefits average 30% of wages.

4. Support and supervision needed will be:

   - Training Coordinator @ $15,000/yr.
   - Secretary @ $7,500/yr.
   - 15% of Training Director's time (35,000/yr.)
   - Foreman - 4 at average $26,000/yr.

5. Acme will have to buy $500,000 worth of equipment for the training with a useful life of 10 years and no scrap value.

6. Miscellaneous costs will be approximately $.06 per hour.

PRODUCTIVITY DATA

1. Apprentices work 40 hours/week.
2. 10% of their week is devoted to theory training.
3. 20% of their time is spent on over-standard work.
4. 10% of their work is scrap.

VENDOR DATA

1. Out-of-pocket costs for purchasing fabricated tooling from outside vendor - $25.00/hour.
2. Internal purchasing costs - $.05/hour.
3. Travel and time of Acme designers to support and assist vendors - $.30/hour.

MODULE 9
COST/BENEFIT ANALYSIS

ATR GUIDEBOOK

Training Costs and Benefits

COSTS

- Development-Staff (instructors/consultants)
- Training equipment
- Training space
- Materials (manufacturing)
- Educational materials
- Travel
- Non-Productive time
  - Waste
  - Over standard production

BENEFITS

- Quickest achievement of competencies
- Less scrap loss and production waste
- Solutions to production problems
- State-of-the-art competencies
- National recognition of training
- Assistance in EEO problems
- Tax credits (where applicable)
- Veterans benefits

Cost/Benefit Analysis Instrument

The following form is for you to use with potential and existing apprenticeship sponsors. The generic term, "trainee," is used throughout rather than the more specific term, "apprentice," so that you can demonstrate the costs and benefits of training in general.

CHART 1

TRAINEE COSTS

TRAINING TITLE	TRAINEES AND HOURS			SALARY		TRAVEL AND PER DIEM	MATERIALS AND SUPPLIES	TOTAL TRAINEE COSTS	
	No. of Trainees	Training Hours (on-the-job and related)	Total Trainee Hours	Hourly Salary plus Benefits	Total Salary	Annual Travel and Per Diem	Annual Cost	Total Trainee Cost	Trainee Cost per Trainee Hour
	1	2	3	4	5	6	7	8	9
DIRECTIONS FOR COMPLETING THE COLUMNS:	Enter total number of trainees per year.	Enter number of training hours per year.	Multiply entry in column 1 by entry in column 2.	Enter salary rates plus benefits. Use a company wide percentage.	Multiply entries in column 4 by corresponding entries in column 3 and enter products here. Total column for training.	Enter total figure if this applies	Enter annual cost of expendable materials and supplies (e.g., workbooks, handouts).	Add totals in columns 5, 6, and 7.	Divide entry in column 8 by column total in column 3 and enter result here. GO TO CHART II

CHART II

														INSTRUCTOR COSTS				
TRAINING TITLE	JOURNEYMEN							RELATED INSTRUCTION STAFF							TRAVEL AND PER DIEM		TOTAL JOURNEYMAN/ INSTRUCTOR COSTS	
	No. Journeymen	Salary per Hour	Overhead per Hour	Salary Plus Overhead	Hours per Year	Annual Salary Plus Overhead Cost	Annual Salary Plus Overhead Cost per Trainee Hour	No. Instructors	Salary Per Hour	Overhead Per Hour	Salary Plus Overhead	Hours Per Year	Annual Salary Plus Overhead	Annual Salary per Trainee Hour	Annual Travel and Per Diem	Annual Travel and Per Diem per Trainee Hour	Total Annual Costs	Annual Cost per Trainee Hour
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DIRECTIONS FOR COMPLETING THE COLUMNS:	Enter no. of journeymen.	Enter average salary (plus benefits) for journeymen.	Enter overhead. (O/H - 100% of base salary or company averages.)	Add entries in columns 2 and 3.	Enter no. of hours spent only on actual instruction or preparing for instruction.	Multiply entry in col. 1 by entry in col. 4 then by entry in column 5.	Divide column total in col. 6 by column total in chart I col. 3.	Enter no. of instructors	Enter average salary (plus benefits) for instructors.	Enter overhead. (O/H -100% of base salary or company average)	Add entries in Col 9 and Col. 10.	Enter no. of hours spent on instruction or prep for instr	Multiply entry in Col. 8 by entry in Col. 11, then by entry in Col. 12.	Divide entry in col. 13 by col. total in Chart 1, col. 3	Enter if this applies.	Enter if this applies.	Add totals in cols. 7, 14, and 16.	GO TO CHART III

BEST COPY AVAILABLE

CHART III

	FACILITIES COSTS										
TRAINING TITLE	TRAINING SPACE				IMPROVEMENTS		EQUIPMENT AND FURNISHINGS			TOTAL FACILITIES COST	
	Annual Cost of Required Space	Hourly Cost of Required Space	Annual Cost of Space for Course	Annual Cost per Trainee Hour	Improvement Costs per Year	Annual Cost per Trainee Hour	Total Cost of Items	Annual Cost of Items	Annual Cost of Items per Trainee Hour	Total Annual Facilities Cost	Annual Facilities Cost per Trainee Hour
	1	2	3	4	5	6	7	8	9	10	11
DIRECTIONS FOR COMPLETING THE COLUMNS:	Obtain from company.	Divide total in col. 1 by 2000 (available training hours in year).	Multiply entry in col. 2 by entry in Chart I, col. 2.	Divide entry in col. 3 by total in Chart I, col. 3.	Enter annual space improvements cost.	Divide entry in col. 5 by total in Chart I, col. 3.	Enter total cost of equipment and furnishing. Group according to those items which will be amortized and those which will not.	If item is to be amortized, divide entry in col. 7 by period of amortization. If not to be amortized, carry cost from col. 7 to this column. Total column.	Divide total in col. 8 by total in Chart I, col. 3.	Add entries in cols. 3 and 5 to total in col. 8.	Add entries in col. 4, 6, and 9. GO TO CHART IV

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CHART IV

TRAINING TITLE	DEVELOPMENT COSTS											
	HOURS AND SALARY						CONTRACT FEES	PRODUCTION	TRAVEL AND PER DIEM	TOTAL DEVELOPMENT COSTS		
	No. Staff	Salary per Hour	Overhead per Hour	Salary Plus Over-Head	No. of Hours Spent on Development	Salary and Overhead Costs				Subtotal of Dev. Costs to be Amortized	Total Annual Dev. Costs	Annual Dev. Costs per Traineee Hour
	1	2	3	4	5	6	7	8	9	10	11	12
DIRECTIONS FOR COMPLETING THE COLUMNS:	Enter number of personnel.	Enter average hourly salary (incl. benefits) for entries in column 1.	Enter hourly overhead for entries in column 1. Obtain percentage from company or use 100.	Add entries in columns 2 and 3.	Enter number of personnel hours spent on development.	Multiply entry in column 4 by corresponding entry in column 5.	Enter portion of any contract fee for course development here. GO TO CHART IVa.	Enter total cost of production (films, slides, texts, etc). from Production Chart IVa. GO TO CHART IVb.	Enter travel and per diem costs. To calculate use Chart IVb.	Add total of column 6 to entry in cols. 7, 8, and 9.	Divide entry in column 10 by period of amortization. This is your annual development cost to be carried to Chart V, box 4a.	Divide entry in column 11 by column total in Chart I, column 3, and enter results here and in Chart V, box 4b.

CHART IVa

PRODUCTION COSTS

TRAINING TITLE:

FILM	COST PER MINUTE	MINUTES PER REEL	NO. OF REELS	TOTAL
TAPES	FEET	COST PER FOOT	NO. OF TAPES	TOTAL
SLIDES	NO. OF SLIDES	COST PER SLIDE	NO. OF COPIES	TOTAL
OTHER				TOTAL

TOTAL PRODUCTION COST

ENTER HERE AND ALSO
ENTER IN CHART IV, COL. 8

COURSE TITLE:

DATE:

CHART V - TOTAL COURSE COSTS

TRAINEE COSTS

1.

A. ANNUAL	B. PER TRAINEE HOUR

DIRECTIONS

A) Enter figure from Chart I, col.7.
B) Enter figure from Chart I, col. 8.

JOURNEYMEN/INSTRUCTOR COSTS

2.

A. ANNUAL	B. PER TRAINEE HOUR

A) Enter figure from Chart II, col. 13.
B) Enter figure from Chart II, col. 14.

FACILITIES COSTS

3.

A ANNUAL	B. PER TRAINEE HOUR

A) Enter figure from Chart III, col. 10.
B) Enter figure from Chart III, col. 11.

DEVELOPMENT COSTS

4.

A. ANNUAL	B. PER TRAINEE HOUR

A) Enter figure from Chart IV, col. 11.
B) Enter figure from Chart IV, col. 12

5.

TOTAL COURSE COST

A. ANNUAL	B. TRAINEE HOUR	C. PER TRAINING HOUR	D. PER TRAINEE

A) Add "A" entries in boxes 1-4. Enter sum in box 5,A.
B) Add "B" entries in boxes 1-4. Enter sum in box 5,B.
C) Divide entry in box 5,A by column total in Chart I, col. 3. Enter result in 5,C.
D) Divide entry in box 5,A by column total in Chart I, col. 1. Enter result in 5,D.

Apprenticeship Benefits Chart 1

1. Direct	2. Indirect	3. Credits/Savings/Reimbursements
A. Increase in Productivity/ Output Per Hour	A. Reduced Turnover	A. Total TJTC
B. Decrease in Production Waste Per Hour	B. EEO Cost Savings	B. OJT Support
		C. Veterans' Benefits
		D. Other Federal/State/ Local Support
Add A + B = _____ Enter on Chart II, Line 1	Add A, B, and C _____ Divide by # of Trainee Hours and Enter on Chart II, Line 2 _____	Add A, B, C, and D _____ Divide by # of Trainee Hours and Enter on Chart II, Line 3 _____

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Benefits - Chart II

1. Direct Benefits ________
2. Indirect Benefits ________
3. Credits/Savings/Reimbursements ________

*Expressed Per Trainee or Appentice Hour

MODULE 10
RESEARCH SOURCES

REFERENCE MATERIALS

Research Sources

The proper attitude towards marketing enables you to link training to the larger world around you and to use resources you might otherwise ignore. Marketers can be more effective when they make use of all the resources available.

RESOURCE CRITERIA

Use several criteria to judge a resource:

- Applicability;
- Timeliness; and
- Reliability/verifiability

TYPES OF RESOURCES

DOL Resources

DOL provides publications such as the Occupational Outlook Quarterly. DOL will soon establish an apprenticeship system clearinghouse and an on-line apprenticeship information data system.

As a long-term goal, DOL will develop a system for determining what occupations to target for special promotional effort. The BAT and the BLS will identify skill shortage occupations involved in defense production. BAT resources also will merge with those of the U.S. Employment Service's Job Bank System, the BLS, the NOICC/SOICC System and Trade Associations in an LMI roster of skilled occupations with persistent imbalances between labor supply and nationwide demand.

To carry out Job Training and Partnership Act activities, DOL will furnish information to state employment and training councils and to PICs on encouraging and sponsoring apprenticeship and preapprenticeship programs. In addition, vocational education agencies and schools will be more closely aligned with DOL.

Computer services produce listings of manufacturing and non-manufacturing firms by geographic area and Standard Industrial Classification (SIC) code. The Department of Labor Main Library provides free computer search services to all DOL employees. The Dialog EIS data bank contains employer information of interest to ATR's. Information is available by geographic location and SIC code for both manufacturing and non-manufacturing industries.

Media Resources

- **Newspapers.** General-circulation newspapers contain sections and features of interest to ATRs; specialized newspapers, including the Wall Street Journal and the Business Employment Weekly, provide more in-depth stories.

- **Magazines.** Business Week, the Economist, Manufacturing News, Harvard Business Review, Trends and Forecasts, The Public Interest, Technology Review, Futurist, are among the hundreds of specialized magazines. General circulation magazines often feature special sections or departments in the fields of business, technology, and forecasting.

- **Books.** Various publications suggest general economic and social trends. Others are directories of manufacturing firms, national trade organizations, and national unions. Many of these publications provide data on the name, address, principal officers, principal product, and number of employees and members of each organization. Several suggested publications include:
    - **Megatrends** by John Naisbitt;
    - **Future Shock** by Alvin Toffler;
    - **Encyclopedia of Associations;**
    - **Thomas Register;**
    - **Standard and Poors Register of Corporations.**

Conferences/Commissions

Hundreds of commissions meet annually and file reports that you can use. Among them are:

- The National Commission for Employment Policy;
- The National Governors Association; and
- The Education Commission of the States.

Use them for overviews of issues and to get an understanding of how American employment and training changes annually, trends in each state, and so on.

These commissions issue annual reports, and special reports on timely or urgent topics. Unions and the National Joint Apprenticeship Councils also produce studies and reports. The Congressional Office of Technology Assessment also prepares useful reports such as their recent Technology, Innovation, and Regional Economic Development.

State Resources

In each state, several agencies provide employment data. For example the Employment Service Representative of the State Employment Security Agency (SESA) provides information on employer needs in the area and on specific employers' occupational structures, explansion plans, hiring requirements and patterns and past experience with employment or training programs. The SESA labor market analyst can identify major employers in the area, provide information on employment and unemployment trends for specific labor market areas, and give you data for high demand occupations in your area.

The State Job Training Coordinating Councils and the State Department of Commerce provide data on new industries moving into the state or industries establishing new plants there.

State agencies issue studies and reports as needed and as part of the annual State of the State report by the governor's office. State trade associations and commisssions also issue their own bulletins. Often, when a State tries to attract new businesses it sets up a commission to study the issue.

Local Contacts

Local Chambers of Commerce provide information on specific employers or industries in your area. County, city, or town governments also have employment and training agencies or departments. Large counties issue government directories and bulletins. Private Industry Councils (PICs) and business and professional associations have formal and informal meetings and reports.

Unions and employers often form joint apprenticeship committees to determine industry needs for particular skills and the training required, and to set standards of acceptance for the programs. These committees may also prove to be valuable resources.

Labor councils and union representatives are good contacts and can provide leads for other union representatives in the area.

Trade schools, vocational schools, and community colleges often have ties to local industry for classroom instruction. Personnel there may want to expand their role by joining your apprenticeship plan, or may be able to refer you to prospects.

Another good resource is a current program sponsor. He can often refer you to other companies or industries that could use apprenticeship training.

Local newspaper offices act as centers for data about an area. The telephone yellow pages is also a good source for a wide range of companies and it is indexed by type of product or service.

MODULE 10
MARKETING RESOURCES

ATR GUIDEBOOK

Types of Resources

Department of Labor

- Publications
- Bureau of Labor Statistics
- U.S. Employment Service
- Job Training and Partnership Act

Media Resources

- Newspapers
- Magazines and journals
- Directories
- Books

Conferences/Commissions

- National Commission for Employment Policy
- National Governor's Association
- Education Commission of the States
- Congressional Office of Technology Assessment
- Unions
- National Joint Apprenticeship Councils

State Resources

- SESA
- Job Training Coordinating Councils
- Department of Commerce
- State of the State Report
- Economic Development Department

Local Contacts

- Chambers of Commerce
- PICS
- Vocational schools
- Current sponsors
- Labor Councils

SUMMARY EXERCISE

Summary Exercise
Background Information
Exacto Chain-Saws

The Product

Gas chain saws are free-standing units powered by an internal combustion engine. The horsepower of the power head varies from 1.5 to approximately 8.5. The more powerful saws are designed for heavy duty uses such as logging and construction, while less powerful saws are used for firewood and light clearing of land. Chain saws are used by professionals such as loggers, builders, or park district employees; farmers; and homeowners or campers. They are available in over 20 different models and a wide range of prices. The useful life of a chain saw is approximately five years. Replacement parts include loops of saw chain, the guide bar, and the sprocket.

Manufacturing Process

Chain saw manufacturing involves a complex assembly operation using a variety of fabricated parts related to the power head and attachments (bar, chain and sprocket). Parts fabrication includes, machining, die casting, forging, heat treatment, plating and metal stamping operations. Die casting involves significant investment, a high degree of difficulty and requires extremely close tolerances.

The largest manufacturers produce almost all of the parts required. Making saw chain and bars requires significant investment and involves sophisticated and often proprietary technology that has been mastered by specialist outside suppliers. Medium sized firms usually purchase attachments, die castings and forgings. They then do their own machining and assembly. Manufacturers that produce more parts internally than they purchase from specialty suppliers are usually more profitable.

Seasonal sales occur as subs are highest in the summer months. The larger firms can accommodate these surges; smaller companies must sub-contract some of their work.

The Company

Exacto Chain Saws, a division of the Master Tool Corporation, is one of the five major manufacturers of chain saws. They are located in a rural area of a western state, with easy access to two large urban areas. Exacto's sales account for 15 percent of the U.S. chain saw market and they are rated fifth in terms of profitability. Their retail prices are in line with the industry standards.

Exacto's planned corporate growth rate for the next ten years is 8 percent however last year's growth rate fell to only 5 percent. One of the reasons they did not achieve an 8 percent growth rate is that Exacto has only a very small die casting facility. All four of their competitors do their own die castings and do not have to sub-contract work during surges as Exacto does. Also, because Exacto does not make their own replacement parts, they are falling even further behind their competitors.

Exacto employs 2,600 persons, 260 of whom are in the skilled trades. The average age of the skilled employees is 42.

Training

Exacto currently has a small, traditional time-based apprenticeship program in their die casting shop, with 15 apprentices registered in the program. Other skilled workers are hired after they have been trained elsewhere.

The training staff are part of the personnel department. They consist of a training director, an apprenticeship coordinator and a secretary.

The ATR maintains monthly contact with the training director. He has offered to make a presentation to management about performance-based apprenticeship programs.

Future Plans

Exacto's long range plans are to expand their in-house die casting facility. They feel, that by developing their own machinery and processes they will be able to raise their profitability. A committee has been formed to study the situation and recommend the most feasible approach to take to accomplish this goal.

History of ATRs Involvement

For the past ten years Larry Baker has been the ATR for Exacto Chain-Saws. When he first began working with the firm they had a registered apprenticeship program very similar to the program currently in place. Larry works with a large number of sponsors; however, he does maintain monthly contact with all of them.

Larry has known Jack Armstrong, the Apprenticeship Coordinator, for most of the past ten years. He thinks that Jack has done a good job for Exacto and recognizes Jack's high level of commitment to apprenticeship. He's been trying for a long time to get Jack motivated to make some changes to the program. For example, the last time Exacto did a job analysis was before Larry became an ATR.

Larry's just beginning to get to know Joe Rutledge. He is aware that Joe is very interested in performance-based programs so he wants to help him any way he can to "sell" the idea to management and to Jack.

Larry's met Bill Dobson on several occasions but never had much of a conversation with him. Larry and Bill are both Dallas fans, but Larry wants to get beyond this superficial commonality and into a situation where he can really tell Bill all about the benefits of apprenticeship.

Personalities

Bill Dobson, Vice President, Personnel and Organization

Bill Dobson joined Exacto four years ago as a 35 year old organizational development specialist. His recent promotion to Vice President was a reward for his successful efforts to improve assembly line productivity. He's known for being a cost conscious manager.

Bill is a Little League coach, an avid football fan, and an active member of the Kiwanis Club. He is independent minded, opposed to government intervention, and very suspicious of government backed training programs. He feels that apprenticeship is not a viable solution to meeting Exacto's training needs and plans to phase out the existing program.

Sharon Jackson, Personnel Director

Sharon Jackson has been with Exacto for 10 years, and has been Personnel Director for 4 years. She has very little involvement with the skills trades employees, as there is seldom turnover in these positions. She has delegated responsibility for apprenticeship to the Training Director. Bill Dobson is her immediate supervisor.

Ms. Jackson is a classical music enthusiast, an active volunteer in the Big Sister program, and a member of a local association of professional women. She does not have strong opinions about government programs. Her experiences with the ATR have been quite positive.

Joe Rutledge, Training Director

Three years ago Joe Rutledge was hired by Sharon Jackson to be Exacto's Training Director. Before joining Exacto he was an Apprenticeship Coordinator for another firm. As Apprenticeship Coordinator he expanded a small, traditional apprenticeship program into a highly innovative performance based program, praised by foremen, management and the apprentices themselves. His long range goals include transforming Exacto's apprenticeship program in a similar manner. So far he has not received much support for his ideas.

Joe works long hours at Exacto, frequently spending evenings and weekends at the plant. He is an enthusiastic employee, very supportive of Exacto's management and personnel policies. He plans to spend the rest of his career at the firm so he's anxious to become highly visible and well thought of.

Jack Armstrong, Apprenticeship Coordinator

Jack Armstrong is an Exacto "lifer". He joined the firm as an 18 year old apprentice in the machine shop and has worked his way up to his present position through hard work and by being a skilled politician. He's close to retirement now, and not much interested in change. He likes the size of the current apprenticeship program, it's what he can comfortably manage. Also, he thinks time-based apprenticeship works well, and has an "it was alright in my day" kind of attitude about the program.

Jack's passion is fishing, and spends most weekends and vacations on the water. He's planning to retire within the next 2 years, and talks about his retirement plans to anyone who will listen. He likes his boss, Joe Rutledge just fine, as long as he doesn't keep trying to make a lot of changes.

Summary Exercise
Background Information
Spurt Technologies Incorporated

The Service

In recent years many private businesses have elected to pucrhase or lease their telephone equipment from firms other than their local AT and T affiliate. Instead, they turn to private concerns such as Telcoa or United Technologies to provide their PBX telephone equipment and internal, computerized switching features. Systems are installed with the capacity for conference calls, call forwarding, paging and other features. These companies install individual telephones, intricate wiring, and the computers that coordinate the system's functions.

Service Delivery System

Once an organization has contracted with SPURT to install and service their new telephone system, a project manager is assigned to the contract. This manager oversees the installation phase from ordering the required trunk circuits from the Telephone Company through training the staff of the organization to use the system. This manager coordinates with the Telephone Company to arrange for cutover, and oversees the installation of the desired equipment. Installation typically involves laying backbase and distribution cable and connecting blocks, establishing a switch room and telephone closet, setting up an equipment room, and connection of all equipment to the master unit.

The Company

SPURT Technologies Inc., is a small, but rapidly growing telecommunications firm. Their customers include businesses, medical facilities, educational institutions and government offices. They are located in an urban area in the southwest, and provide services throughout a tri-state area. Competition has not been a problem for SPURT as there are only three firms in their area providing the same services. They have a good reputation for providing technically-sound, courteous and reasonably-priced services; however, they are developing a reputation for being slow to respond to their customers' installation and repair requests. Their backlog of orders is substantial, and therefore, SPURT hires and trains new installers almost constantly.

SPURT currently employs approximately 3,000 employees, up from 2,200 just last year. Installers and technicians account for 240 of these. They have been hiring new employees at the rate of 25% per month, and have seen their profits double since the business was started three years ago.

Training

SPURT has a central personnel department at their home office, with branches at each major site. Within each personnel department an individual is designated as a training coordinator, responsible for planning and implementing staff development activities.

Other training is handled within the different departments. New installers are assigned to a foreman who works with 3 to 4 new employees at a time. He is responsible for teaching them all they need to know to accomplish the job at hand, and for written appraisals of their performance at given intervals. The foreman recommends raises once established competency levels have been reached by the crew members.

SPURT also recommends that new employees enroll in appropriate evening classes at community college or technical schools. These courses are often not relevant to their on-the-job needs; however, they do provide background theory that is helpful.

Future Plans

SPURT's managers are aware that the firm is growing almost too fast for their own good. They plan to diversify within the next five years, moving into the manufacturing of telecommunications equipment. They have made preliminary projections of their increased staff needs for 1985 and beyond; however, what they have not considered is where these skilled technicians will come from.

History of ATRs Involvement

Chuck Jones first heard about SPURT Technologies Inc., from his friend, Pete Mitchell. Pete's employer recently moved to a new building and used SPURT to install their phone system. Pete was impressed with the installers, particularly the foreman who was teaching his crew of 3 how to complete each step of each task.

Chuck thought this system of training sounded very similar to apprenticeship. He conducted some research, made a few contacts and last month finally got an appointment to meet with the Vice President, John Singer. Mr. Singer was very cordial, listened to Chuck's pitch and then politely explained, "This is a high-tech area, Chuck. Apprenticeship is for the skilled trades like carpentry and plumbing. My Uncle Jake was a plumber, he always had apprentices working with him, but that's not going to work here at SPURT."

Chuck tried to counter with his standard speech on the benefits of apprenticeship, but John still insisted he didn't think that SPURT had any interest in Chuck. Chuck thanked him for his time and promised to be in touch soon with some hard facts about "high-tech" apprenticeship programs that were very effective.

Personalities

John Singer, Vice President for Operations

John Singer is one of the three founders of SPURT. He and two classmates from business school began the firm 5 years ago. Singer comes from a trades background; his uncle was a plumber, his father a building engineer. He is very young, bright and ambitious. His politics are conservative, but in business he's a calculated risk taker.

For Singer, work is everything, he has few outside interests. He doesn't confine himself to his office, however. At least once a month he goes out with one of the crews, just to make sure he knows exactly what's going on down on the front-lines.

Roger Baldwin, Personnel Director

Roger Baldwin was hired by Jon Singer a year ago to oversee management of a rapidly growing work force. Baldwin knows more about the staff development needs of the mid-level managers than the entry-level installers, but he is open to learning more about the skilled trades. Baldwin keeps in close touch with the training coordinators housed at SPURT's local offices.

At the most recent bi-monthly meeting of the coordinators, Baldwin raised the issue of how to insure that adequate training of the installers is occurring now and will continue as the workforce grows.

Baldwin spent a month last summer in Alaska. He loves to talk about his experiences there, in fact, it's hard to get him off the subject. He's a bachelor, lives in the city, and spends much of his free time at concerts and plays.

Andrea Carson, Training Coordinator

SPURT has an area office near Chuck's home where Andrea Carson is the training coordinator. Andrea was originally hired as an administrative assistant, but in a place growing as quickly as SPURT is, it took no time at all for her to advance to her current position. Andrea's eager to learn more about how the installers could be better trained. She's spoken to Roger Baldwin about establishing a more accountable and systematic, performance oriented training program. Roger likes her ideas and has asked her to spend some time researching how other high-tech firms train their technicians.

Summary Exercise
Instructions for ATR Groups

Your group represents an ATR who is planning to market the employer described in your background information. Your assignment is to prepare for a marketing meeting between the ATR and representatives of the company. The materials in your Participant Handbook will serve as resources for your group. The following tasks should be completed to help you prepare for the meeting.

1. Read and discuss the background materials.
2. Decide who will play the role of the ATR at the meeting.
3. You will be notified by the Employer Group as to who will be attending the meeting.
4. Prepare for the meeting using the attached format and checklist.
5. Rehearse among yourselves.

You will have 30 minutes to prepare for a 15 minute meeting.

Marketing Checklist

1. Organize by objectives ____________
2. Assess the product ____________
3. Determine needs ____________
4. Tailor benefits to needs ____________
5. Research ____________
6. Develop a strategy ____________
7. Prepare for briefing ____________
8. Anticipate objections ____________
9. Prepare solutions ____________
10. Establish need for follow-up visit ____________

ATR'S Marketing Analysis

Company ______________________________ ______________________________
name address

Contact ______________________________ ______________________________
name title phone #

Total employees ______________

Major Products/Services ____

____

____

____

Types of Employees

Skilled	Unskilled

% Craftmen/Journeymen ________

Decisionmakers

Name	**Title**	**Reports to**

Current Training Policy

Does a policy exist? ____ yes ____ no

If yes, what is the policy?

Is there a Training Department? ____ yes ____ no

If yes, describe the structure, staff, budget, etc.

ATR's Marketing Plan

1. Objective: ____

____

____

____

____

____

2. **Attributes and Benefits**

Apprenticeship Attributes	Apprenticeship Benefits	How This Can Help The Company

3. Objections/Solutions

Anticipated Objections	Proposed Solutions

4. **Briefing**

Objections:

Attendees:

Approach:

Summary Exercise
Instructions for Employer Groups

Your group represents an employer, as described in the background information. Your assignment is to prepare for a meeting with the ATR assigned to your firm. The materials in your Participant Handbook will serve as resources for your group. The ATR is very interested in becoming more involved with your in-house training programs. The following tasks should be completed to help you prepare for the meeting.

1. Read and discuss the background materials.
2. Make up additional information about your company if you identify any gaps.
3. Decide which personalities will attend the meeting with the ATR and then notify the ATR group.
4. Determine who will play each role during the meeting.
5. Anticipate what the ATR will propose, and prepare appropriate responses.
6. Rehearse among yourselves.

You will have 30 minutes to prepare for a 15 minute meeting.